Neutral Citation Number: [2011] EWHC 3311 (Pat)

Case No: HC10C02090

IN THE HIGH COURT OF JUSTICE
CHANCERY DIVISION
PATENTS COURT

Royal Courts of Justice
Strand, London, WC2A 2LL

Date: 15 December 2011

Before :

THE HON MR JUSTICE ARNOLD

- -

Between :

SANDVIK INTELLECTUAL PROPERTY AB	**Claimant**
- and -	
(1) KENNAMETAL UK LIMITED	**Defendants**
(2) KENNAMETAL EUROPE GMBH	

- -
- -

Iain Purvis QC and **Anna Edwards-Stuart** (instructed by **Charles Russell LLP**) for the **Claimant**
Richard Meade QC and **Andrew Lykiardopoulos** (instructed by **Bristows**) for the **Defendants**

Hearing dates: 16-18, 21-24 November 2011
Further written submissions 8 December 2011

- -

Approved Judgment

I direct that pursuant to CPR PD 39A para 6.1 no official shorthand note shall be taken of this Judgment and that copies of this version as handed down may be treated as authentic.

....

THE HON MR JUSTICE ARNOLD

MR JUSTICE ARNOLD :

Contents

Introduction

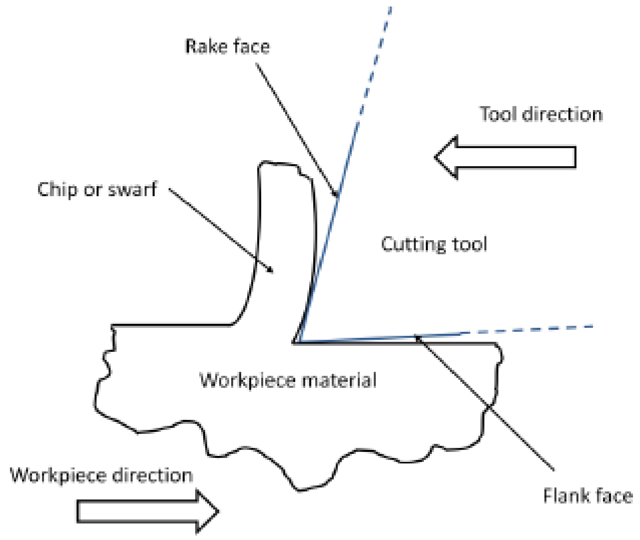
1. In these proceedings the Claimant ("Sandvik") claims that the Defendants ("Kennametal") have infringed European Patent (UK) No. 0 603 144 ("the Patent") entitled "Oxide coated cutting tool". The oxide in question is alumina (Al_2O_3). In fact, claim 1 of the Patent is not limited to cutting tools (that limitation only comes in claim 6), but for all practical purposes this case is about cutting tools. Kennametal denies infringement and counterclaims for revocation on the grounds of lack of novelty, obviousness and insufficiency. Sandvik has made a conditional application to amend claim 1 of the Patent. There is no challenge to the claimed priority date of 18 December 1992.

2. There is parallel litigation in Germany and the USA. This is relevant for two reasons. First, Kennametal rely by way of hearsay notice on evidence given by three Sandvik witnesses given in US depositions. Secondly, Sandvik relies on the judgment of the Landgericht Düsseldorf dated 1 December 2011 upholding Sandvik's claim for infringement of the German counterpart of the Patent. So far as the latter point is concerned, Kennametal point out that the Düsseldorf Court did not have the validity issues before it, nor did it have a lot of the evidence before this court.

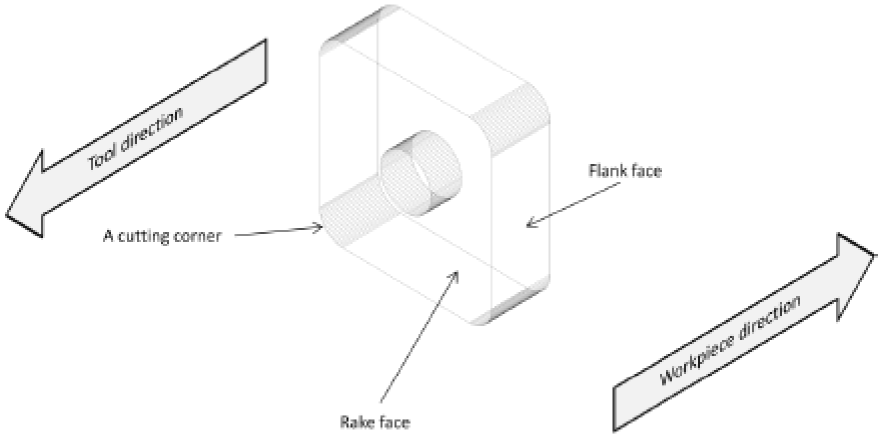
General technical background

Cutting tools

3. A cutting tool is a tool that is used to remove material from a workpiece by means of shear deformation. Cutting tools must be made from a material harder than the material which is to be cut, and must be able to withstand the heat generated in cutting. Chip forming machining is a general term for machining processes in which a tool is used to remove material from the workpiece in the form of discrete chips or ribbons (also known as swarf):



4. Machining tools for use in milling and turning operations commonly have one or more lozenge–shaped "inserts" with up to four usable cutting edges:



5. Inserts of the kind to which this action relates generally consist of a cemented carbide (or other carbide) substrate, a titanium carbide, carbonitride or nitride (TiC, TiCN or TiN) layer and a layer of alumina. The reasons for the choice of alumina as a coating include its hardness and high melting point. Such tools are typically made by chemical vapour deposition ("CVD").

Alumina coatings

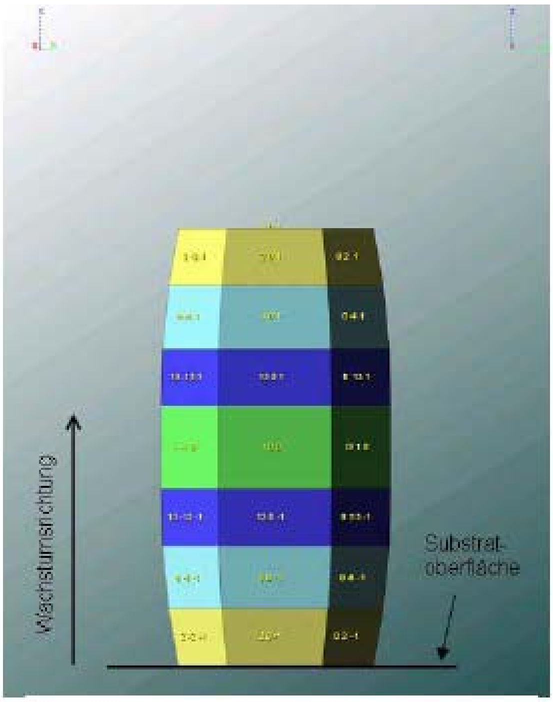
6. Alumina coatings for cutting tools have a number of characteristics relevant to the current dispute. The first is *thickness* measured in µm (microns). In 1992, alumina layers would typically range from 1 to 10 microns thick, but it was possible to deposit thicker layers.

7. The second is *phase*. This refers to the long-range order of the atoms. Some materials can exist in different phases. Alumina can exist in a number of different phases, identified by the Greek letters α, γ, δ, η, κ, θ and χ. These are all crystalline phases i.e. they have a particular long-range order. The two phases which are most relevant to the present case are α and κ. α-alumina (corundum) is the most thermodynamically

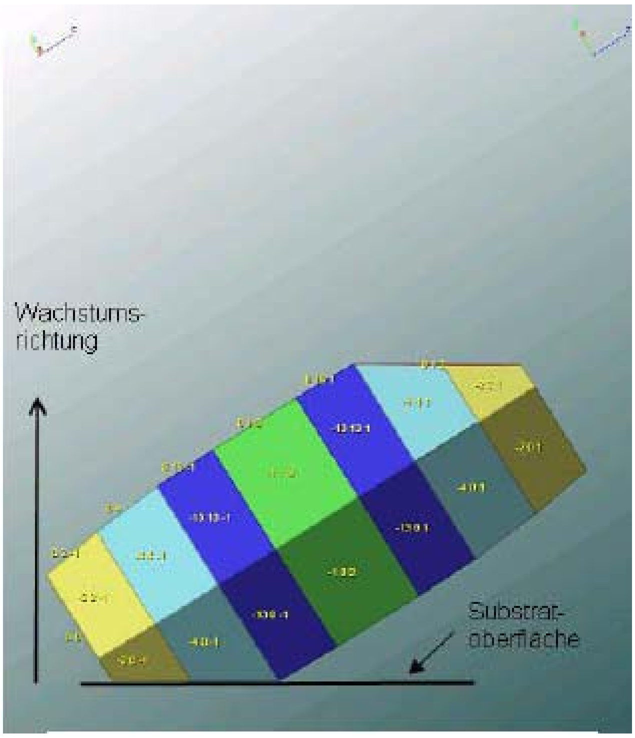
stable phase. κ-alumina is metastable, and at high temperatures it transforms to α-alumina. In addition, alumina may be amorphous, that is to say, having no long range order.

8. The third characteristic is *grain size* expressed in µm. This is a measure of the size of individual alumina crystal grains. When alumina nucleates on a substrate, alumina nuclei will form. A nucleus is a collection of atoms of a material which one is interested in depositing and which is large enough to support growth rather than spontaneously disappear. The nuclei are islands of crystal which eventually join together, forming grains. In 1992 it was well known that the grain size of the coating should be minimised to deliver high hardness and toughness and to produce a smooth coating surface which reduces cutting forces and improves the surface finish on the workpiece after cutting.

9. The fourth characteristic is *texture*. This refers to the orientation of the individual crystals. Not all the individual crystals in a coating will be in the same orientation, and often there will be a mixture of orientations. Crystal planes are defined by a notation system called Miller indices, integers represented by the letters hkl. Each plane is identified by three indices written as (hkl), for example (001). (Sometime a fourth index is included as well, but it is not necessary to go into this.) There are over 50 different crystal planes for alumina. A crystal is said to be oriented in the (001) direction when it is oriented in the direction normal to the (001) crystal plane. This means that the (001) crystal plane is parallel to the substrate and the growth direction is normal to the (001) plane. In this figure the direction of growth is shown by the arrow:



10. Similarly, a crystal is said to be oriented in the (012) direction when it is oriented in the direction normal to the (012) crystal plane. This means that the (012) crystal plane is parallel to the substrate and the growth direction is normal to the (012) plane:



11. Texture can be expressed by a number referred to as the *texture coefficient* or TC (also referred to as T^*). This is calculated using a mathematical formula known as the Harris formula. This is set out in the Patent and I reproduce it below. In essence, it gives the ratio of the orientation in question to the average orientation. This is calculated from X-ray diffraction measurements, as to which see below. In the Patent, only six orientations are measured, namely (012), (104), (110), (113), (024) and (116). Thus the results might be:

TC(012) =	1.4
TC(104) =	1.5
TC(110) =	0.6
TC(113) =	1.0
TC(024) =	0.9
TC(116) =	0.6

12. The values add up to 6, and so the average is 1. If any plane had a value of 6, that would mean that all of the crystals were oriented in that plane when compared with the other five planes specified in the Patent (although other crystals might be orientated in planes not specified). A value of 0 would mean that none of the crystals were in that plane. A value of 1.0 in each plane would indicate a truly random sample (among the planes specified in the Patent). In the example given, it can be seen that the texture coefficient in the (012) direction is 1.4, indicating some degree of preference for that orientation. The texture coefficient in the (104) direction is 1.5, indicating a slightly higher degree of preference for that orientation.

CVD

13. CVD is a common technique for the deposition of coatings. It was the only commonly known technique for deposition of alumina coatings on cutting tools in 1992. In the

CVD process the coating is generated *in situ* by the reaction of gases. Usually, volatile molecular species are transported in the vapour phase to a heated substrate where adsorption and reaction occur to deposit a solid coating. A typical CVD system will thus contain a vapour production system, a reactor chamber which contains the samples to be coated and an effluent treatment system. Deposition typically occurs at or below atmospheric pressure.

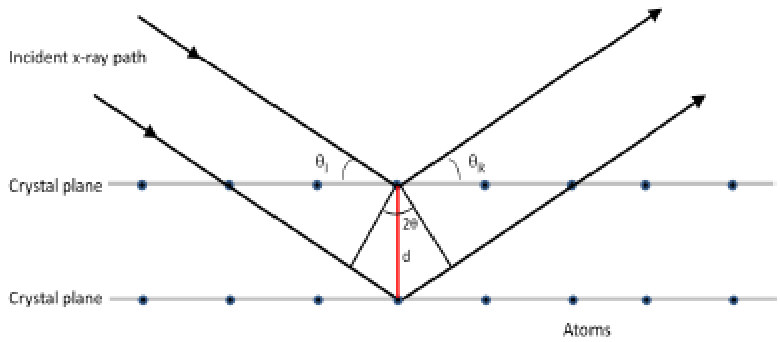
14. Alumina is usually deposited by reacting aluminium trichloride ($AlCl_3$) with water generated from hydrogen and carbon dioxide by the water gas shift reaction:

$$H_2 + CO_2 <-> H_2O + CO$$

$$2AlCl_3 + 3\ H_2O -> Al_2O_3 + 6\ HCl$$

X-ray diffraction

15. X-ray diffraction is a convenient non-destructive analysis technique that has been widely used in the study of coatings. The technique has been in use since the 1920s and is one of the most useful methods of analysing crystalline materials. X-rays are high energy photons which have a wavelength which is of a similar size to the atomic spacing in solids. For this reason the x-rays are able to scatter from solids in a way which provides information about the crystallographic structure of the material, a process known as diffraction. The incident x-ray beam interacts with parallel arrays of atoms (crystallographic planes) separated by a distance d. Each atom scatters the incident x-rays. These scattered x-rays generally interfere destructively with each other, but at certain unique angles constructive interference occurs and a diffracted beam is produced:



16. The crystallographic planes in the material parallel to the test surface which have a fixed spacing are responsible for the diffracted beam which is captured by the detector. Not all grains will be suitably oriented to contribute to the diffracted beam. The crystal structure of the material analysed will generate a number of crystallographic planes defined by the Miller indices hkl with spacing d_{hkl}, depending on its crystal system and lattice parameters. The relationship between d_{hkl} and the diffraction angle 2θ is given by Bragg's Law:

$$n\lambda=2d_{hkl}\sin\theta$$

where n is an integer, λ is the x-ray wavelength, and θ is one half of the diffraction angle, 2θ.

17. It is usual to use an experimental procedure to collect a diffraction pattern over a wide range of diffraction angles in order to capture a sufficient number of peaks corresponding to hkl reflections and measure the angular positions and intensities of each of these peaks. Then, using Bragg's law, each peak position is used to convert the 2θ into d values that describe the various crystalline planes in the test sample. The intensity of an x-ray spectrum is usually represented as an arbitrary scale as it will depend critically on the intensity of the incoming x-ray beam and losses in the diffractometer. It is conventional to set the maximum intensity of the strongest peak in the spectrum to 100% and scale the other peaks accordingly. In a correctly set-up diffractometer the peaks are sharp and their angular positions can be measured to an accuracy of better than one hundredth of a degree. For a polycrystalline material, the diffraction pattern will consist of a series of peaks at well-defined values of 2θ. The peak positions can be used to determine the phase of the same, while the relative peak intensities are used to calculate the texture coefficient.

The skilled person or team

18. A patent specification is addressed to those likely to have a practical interest in the subject matter of the invention, and such persons are those with practical knowledge and experience of the kind of work in which the invention is intended to be used. The addressee comes to a reading of the specification with the common general knowledge of persons skilled in the relevant art, and he or she reads it knowing that its purpose is to describe and demarcate an invention. He (or she) is unimaginative and has no inventive capacity. In some cases the patent is addressed to a team of persons with different skills.

19. In the present case there is no dispute as to the identity of the skilled person to whom the Patent is addressed. The skilled person would be involved in the development of alumina-coated cutting tools. As such, the skilled person wuold need to be knowledgeable about two main areas: (i) alumina and other coatings for cutting tools, and CVD processes for making them; and (ii) characterisation techniques, in particular XRD and scanning electron microscopy (SEM). One person might be knowledgeable about both areas (as in the case of Kennametal's expert Professor Bull) or a team of two might be required, a coatings process engineer (such as Sandvik's expert Dr James) and a materials analyst (such as Sandvik's expert Professor Thomas). In the case of smaller companies in the field, the materials analyst might well be an external expert.

The witnesses

20. Dr Martin James gained a BSc (Hons) in Metallurgy in 1968 and a PhD in Metallurgical Thermodynamics in 1973, both from the University of Nottingham. He was employed by the Sandvik group from 1975 to 2006. From 1985 to 1997 he worked for Sandvik Coromant in Sweden. From 1985 to 1995 his role was in process development on the production side, working on the development and production of grades of cutting tool inserts. In 1995 he became Production Manager for Sandvik Coromant worldwide. From 1997 to 2006 he worked for Sandvik Hard Materials. From 2006 to 2008 he was a part-time consultant for Sandvik Tooling. He retired in 2008.

21. Professor Pamela Thomas gained BA (Hons) in Physics in 1983 and DPhil on Optical Activity in Crystals in 1987, both from the University of Oxford. After a period as a post-doctoral research assistant in the Clarendon Laboratory, she was successively Lecturer, Senior Lecturer and Reader in Physics at the University of Warwick, where she has been Full Professor of Physics since 2005 and Chair of the Faculty of Science since September 2011. She has many years' experience of XRD, as well as SEM, and is highly expert in that field. Before being instructed as an expert in these proceedings, however, she had no previous experience with coated tool inserts of the type the subject of this dispute. In 1992 she had limited experience of alumina layers or even thin film layers more generally. She had not used the Harris formula in 1992, and had only done so in a limited way later in the 1990s.

22. Professor Stephen Bull gained a BA (Hons) in Metallurgy and Materials Science in 1984 and PhD on the Mechanical and Tribological Properties of Implanted Ceramics in 1987, both from the University of Cambridge. From 1988 to 1996 he was employed in the Coatings and Interface Technology Group of the Surface Science and Technology Division of the Harwell Laboratory (initially part of the United Kingdom Atomic Energy Authority, later AEA Technology and the AEA plc). In this capacity, he worked with a range of coatings for different applications including tooling. During this period he was part of a research group called the Engineering Coatings Club, which carried out contract research for industrial members of the Club in the field of coatings, including for cutting tools. From 1996 to 2007 he was successively Reader and Professor of Surface Engineering at Newcastle University, where he has been Cookson Group Chair of Materials Engineering since 2008.

23. Professor Bull has considerable expertise both in the use of CVD for coating tools and in the analysis and characterisation of coatings via XRD and SEM techniques. The majority of his work at Harwell in the early 1990s was in respect of TiN, TiC, TiCN and alumina coatings. On the other hand, in 1992 he did not have hands-on experience of coating cutting tools with alumina by CVD (although he did have experience of coating them by the related technologies of physical vapour deposition and plasma spray).

24. All three experts were good witnesses whose evidence I found of assistance. It is no fault of theirs that none of them was fully representative of the skilled person. Dr James' perspective was inevitably that of someone who had worked at Sandvik for almost all of his working life, and he had little experience on the research side. Professor Thomas had expertise in XRD, but no experience of measuring texture coefficients of alumina at the relevant date. Professor Bull had the advantage that he had experience both of coating processes and of texture measurement, but even he was not quite representative of the skilled person from the perspective of his CVD experience. Nevertheless, I believe that, taken together, the evidence of the experts provides a good picture of the position.

25. In addition to the experts, a number of factual witnesses gave evidence on both sides which was not challenged. Furthermore, both sides relied on hearsay evidence. In particular, as noted above, Kennametal relied on extracts from the deposition testimony of three Sandvik witnesses in the parallel US proceedings, namely Björn Ljungberg (one of the inventors of the Patent), Dr Gunnar Brandt (an internal IP advisor) and Lennart Karlsson (an employee of Seco, a competitor to Sandvik which is now owned by it).

Common general knowledge

26. I reviewed the law as to common general knowledge in *KCI Licensing Inc v Smith & Nephew plc* [2010] EWHC 1487 (Pat), [2010] FSR 31 at [105]-[115]. That statement of the law was approved by the Court of Appeal [2010] EWCA Civ 1260, [2011] FSR 8 at [6].

27. In the present case there is a fair amount of common ground with regard to common general knowledge, but there are also a number of differences between the parties. In addition to the matters set out in the general technical background section above, which are uncontroversial, I find that the following matters were common general knowledge at the priority date of the Patent.

The Chatfield Paper

28. It is convenient to begin with a paper by Chatfield et al, "Microstructure of CVD - Al_2O_3", *Journal de Physique*, C5:5 (1989), C5-377-388 ("the Chatfield Paper"). Since (i) Kennametal rely on this paper as prior art, (ii) it is common ground that the paper's contents would have been common general knowledge by the priority date, and (iii) the parties seek to extract different messages from the paper, it is necessary to consider the paper in a little detail.

29. In the introduction the authors comment that, although the reaction mechanisms occurring during the CVD of Al_2O_3 have been analysed on several occasions, little has been said about the stability and microstructure of the deposited alumina phases and how the formation of these phases depends on the deposition process. Accordingly, the purpose of their paper is to elucidate the crystallography, microstructure and morphology of the α- and κ-phase of CVD-Al_2O_3 and how the conditions in the nucleation stage determine which of these phases, or a mixture thereof, grows. Since in commercial tools alumina is deposited on TiC cemented carbides, the interface reactions on the TiC surface are of special importance.

30. Having discussed the alumina deposition process, the authors consider the morphology and microstructure of alumina coatings and the TiC/Al_2O_3 interface by reference to a number of Transmission Electron Microscopy (TEM) micrographs. In this section, they point out that a higher ratio of α-Al_2O_3 to κ-Al_2O_3 is obtained for longer coating process times and additional heat treatments because the metastable κ-Al_2O_3 is transformed to α-Al_2O_3. They observe that a 100% α-Al_2O_3 coating is coarse-grained and porous, whereas a κ-Al_2O_3 coating is fine-grained and essentially pore-free. Furthermore, they observe that an Al_2O_3 coating which adheres poorly to TiC is α-Al_2O_3 and exhibits considerable porosity at or near the interface while an Al_2O_3 coating which adheres well to TiC is κ-Al_2O_3 and pore-free. They go on to note that κ-Al_2O_3 in contact with TiC has a well-defined lattice orientation relationship between TiC and Al_2O_3, whereas there is no such relationship between TiC and α-Al_2O_3. They also note, however, that the relationship between TiN and α-Al_2O_3 is the same as that between TiC and κ-Al_2O_3.

31. The authors say that it is clear from these TEM investigations that the process conditions during the early nucleation stage of Al_2O_3 on TiC are of the utmost importance not only to obtain good bonding, but also for the subsequent growth of the coating. They then state there is very strong indirect evidence that the oxidation

state(s) of the TiC is critical for the type of nuclei being formed. If the TiC surface is deliberately oxidised before Al_2O_3 deposition, α-Al_2O_3 is always obtained and κ-Al_2O_3 very rarely. Simple thermodynamic calculations show that the presence of H_2O in H_2 has a drastic effect on oxidation of the TiC surface: oxidation of TiC to Ti_2O_3 is possible for as little as 5 ppm H_2O in H_2, while if there is more than 25 ppm H_2O TiC oxidises predominantly to Ti_3O_5. Transformation of TiC to either oxide is accompanied by a 25-30% volume expansion. They go on to discuss the kinetics of the reactions.

32. In the discussion section the authors conclude as follows:

> "To rationalize [the findings from the TEM investigations] with the above analyses of the kinetics of the surface oxidation of TiC, one has to conclude that it is very plausible that the nucleation resulting in α-Al_2O_3 does not occur on TiC but rather on a very thin titanium oxide film, e.g. Ti_2O_3 or Ti_3O_5 …, and hence, makes it impossible to develop [an] epitaxial relationship with the underlying TiC facet. However, since there is no evidence from the TEM investigations of any trigonal (Ti_2O_3) or monoclinic (Ti_3O_5) titanium oxide interface TiC with Al_2O_3, it must be assumed that a transformation back to the fcc TiO or TiCO phases has occurred during the fairly long deposition period. The volume contraction (25-30%) accompanying the phase transformations would then explain the observed interface porosity.
>
> In contrast, κ- … Al_2O_3 nucleate[s] directly on non-oxidised TiC facets which results in an epitaxial relationship between TiC/Al_2O_3 and the absence of interface porosity. The subsequent kinetics behind the phase transformation of the metastable κ- to α-Al_2O_3 is not clear. It is possible that small changes in the composition of the coating, or the influence of impurities, alter the phase stabilities. It should be pointed out, however, that only small rearrangements of the close-packed oxygen layers are needed to convert κ-Al_2O_3 to α-Al_2O_3."

33. Kennametal contend that the Chatfield Paper teaches the importance of controlled oxidation for nucleating α-alumina and of keeping the water content of the hydrogen below 25 ppm. I accept the first part of this, but not the second. I cannot see anything in the paper which indicates that the water content must be kept below 25 ppm. Sandvik contends that the Chatfield Paper teaches that α-alumina nucleated on Ti_2O_3 or Ti_3O_5 on the surface of the TiN, but that this was undesirable because it led to porosity and poor adhesion. I accept that the paper teaches this in relation to TiC, but not in relation to TiN. The paper implies, although it does not expressly state, that it ought to be possible to nucleate α-alumina on TiN with low porosity and good adhesion.

Alumina coated tools generally in 1992

34. Since α-alumina was the thermodynamically stable form, pure α-alumina was considered to be the most desirable phase for alumina coatings. The fact that κ-

alumina was metastable was clearly a drawback. It was also known that fine-grained coatings were desirable in order to deliver hardness and toughness and to produce a smooth surface. It was also known that the coating had to adhere well to the substrate and not flake off. Thus it was appreciated that what was wanted was a fine-grained, well-adherent α-alumina coating.

35. 100% κ-alumina, mixed κ/α-alumina and 100% α-alumina coated cutting tools were all known in the marketplace in 1992. In the 1970s and early-mid 1980s the industry had made pure α-alumina coated tools, and mistakenly thought that the coatings had been deposited as α-alumina. The Chatfield Paper had showed, however, that it was probable that the CVD processes then being used, which involved lengthy exposure to high temperatures, deposited κ-alumina which was transformed to α-alumina during the course of the process. In the late 1980s a faster process using hydrogen sulphide (H_2S) as a catalyst was introduced in which this did not occur, or at least not to the same extent. After this, 100% κ-alumina and mixed κ/α-alumina coatings became more common.

36. By 1992 it was possible to produce fine-grained α-alumina coatings, but this could only be done commercially by depositing κ-alumina and transforming it to α-alumina. Such coatings tended to suffer from flaking, however. It appears that some people may have been able to make fine-grained, well-adherent transformed or nucleated α-alumina coatings on a laboratory scale, but there were serious difficulties in making such coatings on a commercial scale.

CVD equipment

37. The leading supplier of CVD reactors in 1992 was Bernex. Most cutting tool manufacturers either had a Bernex or built their own. There were two main types of reactors, those with an axial flow arrangement and those with a radial flow arrangement. Some reactors could be used in either mode.

CVD processes for depositing alumina

38. The following aspects of the CVD process were common general knowledge:

i) It was conventional to purge the reactor between depositing TiCN and depositing alumina. There is a dispute as to what gas or gases were used for this purpose which I will deal with below.

ii) It was well known basic chemistry that the water gas shift reaction could be driven to the right or the left by adding CO_2 or CO.

iii) It had been known since the Chatfield Paper that controlling the water vapour concentration in the hydrogen gas was a key issue.

iv) It was conventional to deposit alumina at a temperature of about $1000^{o}C$.

39. Apart from generalities such as I have set out in the technical background section and in the preceding paragraph, the precise details of manufacturers' processes tended to be closely guarded trade secrets.

Texture of alumina coated tools

40. It was common general knowledge in 1992 that alumina coatings could have a texture and that this could affect the performance of the tool. Thus the skilled person would have appreciated that, in theory, certain orientations might give better performance than others, but he would not know which would be the better ones.

41. There was little information available about the texture of α-alumina coatings before the priority date. A paper by Kim et al, "Effect of partial pressure of the reactant gas on the chemical vapour deposition of Al_2O_3", *Thin Solid Films*, 97 (1982) 97-106 ("Kim"), which is agreed to have been common general knowledge, found that the crystallographic structure of α-alumina film changed from random orientation to (104) preferred orientation with increasing deposition. A review article by Lux et al, "Preparation of alumina coatings by chemical vapour deposition", *Thin Solid Films*, 138 (1986) 49-64, the contents of which I find to have been common general knowledge, reported that the typical preferred orientations were in the (104), (116) and (124) directions. Counsel for Sandvik submitted that these reports both related to nucleated α-alumina. It is not clear to me that this is correct, but even if it is, I am not satisfied that the skilled person would have been conscious of it.

42. Importantly, it is common ground that the skilled person would *not* have known from his common general knowledge in 1992 how to achieve any particular texture, including texture in the (012) direction.

XRD

43. There are three important issues as to the common general knowledge relating to XRD analyses. These all arise from the fact that the Patent refers to "the ASTM standard powder pattern diffraction data", but it does not specify precisely which data it is referring to, nor does it give any details of the precise manner in which the XRD analysis is to be carried out.

44. *PDF cards*. From 1941 to 1969 the American Society for Testing and Materials (ASTM) supported and sponsored the collection and distribution of standard powder diffraction data. These were originally distributed on individual cards referred to as Powder Diffraction File or PDF cards. This terminology is still used even though, as discussed below, the files have ceased to be kept on cards. In 1969 responsibility for PDF cards passed to the Joint Committee on Powder Diffraction Standards (JCPDS) which in 1978 was re-named the International Centre for Diffraction Data (ICDD).

45. On each PDF card, standard diffraction data is presented in the form of a table of d-spacings relating to the crystallographic planes in the material, the relative intensity of those planes and the Miller indices of the peaks observed in the diffraction pattern. The peak positions are related to the interplanar spacings (d_{hkl}), and may be used to identify the material and crystal structure of a sample under test. The intensities are not directly related to d_{hkl}, but depend on the crystal structure in a complex manner.

46. By the 1970s PDF cards were supplemented by PDF data books summarising a subset of the available data (e.g. there were books for metals and alloys) and by microfiche. In addition, the ICDD published an annual Alphabetical Index. In the late 1980s computerised searchable versions of the PDF were produced on floppy disks and by

the early 1990s on CD-ROMs, although these were not common in 1992. It was not unusual to have only some of these media (cards, searchable books, microfiche and floppy disks or CD-ROM) available in an XRD lab in 1992.

47. It is important to appreciate that, as new or improved information became available for a substance, a new PDF card would be issued. Thus for substances such as α-alumina, there was more than one PDF card.

48. One of the functions of the ICDD is critically to review the published XRD data and improve the quality of the PDF database. The data is reviewed for technical correctness, accuracy in transcription and overall quality. The overall quality is indicated by a Quality Mark. The quality marks for experimental patterns are * (star – no warnings), I (indexed – minor warning), B (blank – significant warnings) and 0 (zero – major warnings). There is little to choose between a * quality card and an I quality card.

49. In December 1992 nine PDF cards were available for α-alumina. Professor Thomas and Professor Bull were agreed that only two of these were of good quality, namely 10-0173 and 42-1468. 10-0173 was originally published in 1960 and revised in 1967. 42-1468 was published in July 1992. It bore a statement that it was "to replace 10-0173".

50. Professor Thomas and Professor Bull were also agreed that there were two methods of selecting a PDF card for use in XRD analysis of α-alumina in December 1992, both of which were in accordance with the common general knowledge. The first method would be to look up α-alumina in the ICDD Alphabetical Index. The 1992 Alphabetical Index only cited the 42-1468 card. Thus the skilled person who employed this method would be led to the 42-1468 card, and would not be conscious of the possibility that there was an alternative choice of PDF card.

51. The second method would be to search whatever PDF database the skilled person had available, be it a collection of cards, a book, a microfiche or a computerised database, to find the available PDF cards and then to select one of suitable quality. The skilled person who employed this method would either find both the 10-0173 and the 42-1468 cards, if their database was up to date, or just the 10-0173 card, if it was not up to date. In the latter case, the skilled person would again not be conscious of the possibility that there was an alternative choice of PDF card (other than those which would be rejected as being of insufficient quality). In the former case, the skilled person would be conscious of having to make a choice as to which card to use.

52. Professor Thomas and Professor Bull were also agreed that there was a tendency for laboratories to continue to use the same PDF cards as had previously been used for a particular investigation, both as a simple matter of habit and for consistency. It follows that, if the skilled person had to make a choice of PDF card and he or she had previously carried out XRD analyses of α-alumina, he or she would be likely to choose 10-0173, since that card would be likely to have been the card used previously. This would not apply if the skilled person was analysing α-alumina for the first time, however.

53. It follows that a skilled person carrying out an XRD analysis of α-alumina coatings in accordance with the common general knowledge for the purposes of calculating TC

values in December 1992 might have done any of the following:

i) selected the 42-1468 card without being conscious that 10-0173 was an alternative possibility;

ii) selected the 10-0173 card without being conscious that 42-1468 was an alternative possibility;

iii) selected the 10-0173 card as a matter of conscious choice for the reasons given above;

iv) been uncertain as to whether to choose the 10-0173 or 42-1468 card.

54. This conclusion appears to be consistent with the conclusion of the Düsseldorf Court at page 35 of its judgment that the skilled person would use one of these two cards.

55. *Kα2 stripping*. The most common source of x-rays for XRD is a copper x-ray tube which produces two distinct, but very close, wavelengths, Kα1=1.540562Å and Kα2=1.544390Å. A diffraction peak for a given crystallographic plane is produced for each of these two wavelengths, and the two closely spaced peaks are summed to make the reflection measured. A Kα2 peak has half the intensity of the Kα1 peak, but its angular separation from the Kα1 peak is not constant.

56. Professor Thomas and Professor Bull were agreed that, in some circumstances, it was known to be necessary to remove the contribution to a measured peak emanating from the Kα2 component (referred to as "Kα2 stripping"), so as to allow just the Kα1 component to be analysed. Generally speaking, this is important where there is a difference between low angle peaks and high angle peaks. For peaks at low angles, the existence of the Kα2 peak can lead to an artificial increase in the measured I(hkl) since the two peaks are very closely spaced. For peaks at high angles, it may be possible to resolve the Kα1 and Kα2 peaks. In these circumstances, it is necessary to strip the Kα2 component from the low angle peaks. Professor Thomas and Professor Bull were also agreed that this can be the case with α-alumina.

57. It is common ground that both the 10-0173 and 42-1468 PDF cards specify that the data are based on Kα1 radiation. In principle, it follows that a user of either of those cards should carry out Kα2 stripping in order to obtain an accurate result. Kennametal contend, however, that the evidence shows that this was not done as a matter of routine. Rather, some skilled persons would do it, some would not and some would use their judgment as to whether to do it or not.

58. Professor Bull pointed out that in 1992 many people still had diffractometers with chart recorders. While techniques existed for Kα2 stripping data obtained using a chart recorder, they were difficult and time-consuming. Accordingly, it was his opinion that some skilled people in that position would not do it. Professor Thomas agreed that it was very likely that people with chart recorders would not strip the Kα2 component. By contrast, as she pointed out, for those who had diffractometers with digital data collection, there were algorithms built into the software which carried out Kα2 stripping at the click of a button.

59. Furthermore, Professor Thomas agreed that, even with computerised diffractometers,

Kα2 stripping was always optional. This is demonstrated by what Professor Thomas herself did when carrying out Sandvik's experiments in this case. In the experiments described in Sandvik's first notice of experiments, she did not carry out Kα2 stripping. She explained that this was because the Kα1 and Kα2 peaks overlapped at both low and high angles, and thus it was not necessary to do so because the calculation of TC value is based on relative peak heights. By contrast, in the experiments described in Sandvik's second notice of experiments, she did carry out Kα2 stripping. She explained that this was because in this case the Kα2 peaks were well resolved at high angles, but not at low angles. Thus she exercised her judgment as to whether or not to do it depending on whether she thought that it would make a significant difference to the results.

60. The conclusion I draw from this evidence is that some skilled persons carrying out an XRD analysis of α-alumina coatings using the 10-0173 or 42-1468 cards in accordance with the common general knowledge for the purposes of calculating TC values in December 1992 in the absence of an explicit direction would carry out Kα2 stripping, some would not and some would exercise their judgment on a case by case basis.

61. This conclusion is broadly consistent with the apparent conclusion of the Düsseldorf Court at page 35 of the judgment that skilled persons with computer-assisted diffractometers would have made the correction, but those with other diffractometers (i.e. those with chart recorders) might or might not. Furthermore, I note from page 43 of the judgment that Sandvik did not carry out Kα2 stripping in its experiments for the purpose of the German proceedings, but instead carried out a Fourier transformation which the Düsseldorf Court considered to be equivalent. Whether that is so or not was not explored in the evidence before me.

62. *Thin film correction.* The Harris method for texture coefficient calculation was developed for infinitely thick samples. If one is analysing a thin film of α-alumina, the intensity of the α-alumina peaks is likely to be reduced when compared to a bulk sample. In these circumstances, a thin film correction should, in theory, be applied to the I(hkl) data to correct for the divergent path length of the incident x-ray beam through the coating as a function of incidence angle. When the x-ray beam enters the α-alumina coating at a shallow angle (as in the case of the (012) reflection), the x-ray beam travels a relatively long path length in the alumina resulting in a strong diffracted intensity for the (012) reflection. Conversely, when the x-ray beam enters the α-alumina coating at a higher angle (e.g. for the (116) reflection) the path length is shorter, resulting in more absorption in the layers below the α-alumina and a weaker diffracted intensity. The overall effect is to increase the I(hkl) for (012) and reduce it for the higher angle reflections leading to an increased texture coefficient for (012) α-alumina. This can be corrected by a thin film correction.

63. Professor Bull and Professor Thomas were agreed that whether an XRD analyst applied a thin film correction or not would depend on their background. Professor Bull, who was better placed to know than Professor Thomas, said that he did not think it was done routinely by people carrying out the Harris test on alumina coatings. It would only be done if the testing was farmed out to someone with experience of analysing semiconductor thin films, where it was done routinely. As he put it, "It was just not something that was on the horizon, really, for the vast majority of people".

64. The conclusion I draw from this evidence is that a skilled person carrying out an XRD analysis of α-alumina coatings in accordance with the common general knowledge for the purposes of calculating TC values in December 1992 would not carry out a thin film correction. This conclusion is consistent with that of the Düsseldorf Court at page 38 of its judgment.

65. *Other matters*. In addition to the three points considered above, Kennametal contended that the XRD results would also be affected by a number of other experimental variables, in particular (i) the use of fixed or variable slits, (ii) the size of the slit (if fixed) or area to be irradiated (if variable), (iii) the sample orientation, (iv) whether measurements were made of peak height or peak area and (v) whether to smooth or filter the data. These matters were not pursued by counsel for Kennametal in his closing submissions, however.

66. On the other hand, it is common ground that the skilled person would be aware that there was a random general experimental error in the results of about ±10%. The evidence is unclear whether this represented the error from the perspective of repeatability (i.e the error to be expected from repeat measurements by the same person using the same equipment) or reproducibility (i.e. the error to be expected from measurements by different persons using different equipment). I suspect that it is the former, and that the reproducibility error was higher. Neither side suggested that this mattered, however.

The Patent

67. The specification begins by stating that the invention relates to a coated cutting tool for chipforming machining (page 2 line 3). It goes on to acknowledge that CVD of TiC, TiN and Al_2O_3 to produce wear resistant coatings of cutting tools is well known (page 2 lines 4-10). It then states (page 2 lines 11-15):

> "Cemented carbide cutting tools coated with various types [of] Al_2O_3-coatings, e.g., pure κ-Al_2O_3, mixtures of κ- and α- Al_2O_3 and very coarse-grained α-Al_2O_3 have been commercially available for many years. None of these oxide coated products have shown desirable cutting properties when used for machining nodular cast iron. Nodular cast iron is a work piece material difficult to machine since it adheres onto the cutting edge of the tool resulting in a successive and fast removal of the coating from the cutting edge and, hence, a shortened tool life of the cutting insert."

68. The specification notes that "Al_2O_3 crystallises in several phases: α, κ, γ, β, θ etc" and that the two most common phases in CVD of wear resistant alumina coatings are the thermodynamically stable α-phase and the metastable κ-phase (page 2 lines 16-17). It goes on (page 2 lines 18-21):

> "Generally, the κ-phase is fine-grained with a grain size in the range 0.5-2.0 μm and often exhibits a columnar coating morphology. Furthermore, κ-Al_2O_3 coatings are free from crystallographic defects and free from micropores or voids. The α-Al_2O_3 grains are usually coarser with a grain size of 1-6

> μm depending upon the deposition conditions. Porosity and crystallographic defects are in this case more common."

69. At page 2 lines 22-26 the specification states:

> "In commercial cutting tools, Al_2O_3 is always applied on TiC coated carbide or ceramic substrates … and therefore the interfacial chemical reactions between the TiC-surface and the alumina coating are of particular importance. In this context the TiC layer should also be understood to include layers having the formula $TiC_xN_yO_z$ in which the carbon in TiC is completely or partly substituted by oxygen and/or nitrogen."

70. The specification then refers to five prior patents which disclose oxide coated bodies, and says (page 2 lines 30-33):

> "Although the disclosed methods result in alumina layers tightly and adherently bonded to the cemented carbide body or to a refractory layer of e.g. TiC adjacent to the cemented carbide, they do not result in the particular α–polymorph of Al_2O_3 as disclosed in the present invention."

71. The specification next acknowledges three more patents as disclosing alumina–coated bodies, including European Patent Application No. 0 403 461, ("the Chatfield Application"), but says that these patents do not disclose (page 2 lines 36-37):

> "the desired microstructure and crystallographic texture of the α–polymorph which is the object of the present invention".

72. The specification then identifies two objects of the invention. The first (page 2 lines 37-40) is:

> "to provide, on a hard substrate or preferably onto aforementioned $TiC_xN_yO_z$ coating at least one single phase Al_2O_3 of the polymorph α with a desired microstructure and crystallographic texture using suitable nucleation and growth conditions such that said properties of the Al_2O_3 layer are stabilized."

73. The second (page 2 lines 41-42) is:

> "to provide an alumina coated cutting tool insert with improved cutting performance in steel, stainless steel, cast iron and, in particular, in nodular cast iron."

74. The invention is introduced at page 2 line 45 – page 3 line 28. The specification claims (page 2 lines 48-49) that:

> "A coated cutting tool in accordance with the present invention exhibits improved wear and toughness properties compared to prior art tools when used for machining steel or cast iron…"

75. The key features of the invention are identified at page 2 line 55 – page 3 line 7: “at least one of the layers in the coating structure comprises a fine-grained, preferentially textured layer of single phase α- Al_2O_3 having a thickness of d = 0.5-25 μm with a grain size (s) [within the ranges specified in claim 1]”. The specification explains that the grain size is “determined from a SEM top view micrograph at 5,000X magnification” by a procedure which is briefly explained (page 3 lines 11-13). It also explains that the Al_2O_3 layer has “a preferred crystal growth orientation in the (012) direction which is determined by X-ray Diffraction (XRD) measurements” (page 3 lines 14-15). It sets out the Harris formula for determining texture coefficient or TC which is repeated in claim 1, and states that according to the invention “TC for the set of (012) crystal planes is larger than 1.3, preferably larger than 1.5” (page 3 lines 16-28). Nowhere, however, does the specification give any reason for the choice of 1.3 or 1.5.

76. At page 3 line 31ff, the specification states:

> “The textured Al_2O_3-coating according to the invention is obtained by careful control of the oxidation potential of the hydrogen carrier gas, preferably below 20 ppm, most preferably below 5 ppm, of H_2O, prior to the nucleation of Al_2O_3. The nucleation of Al_2O_3 is started up by sequencing the reactant gases in the following order: CO_2, CO and $AlCl_3$. The temperature shall preferably be about 1000^oC during the nucleation. However, the exact conditions depend to a certain extent on the design of the equipment used. It is within the purview of the skilled artisan to determine whether the requisite texture has been obtained and to modify the deposition conditions in accordance with the present specification, if desired, to effect the amount of texture.”

77. The specification then claims (page 3 lines 38-39) that:

> “The α-Al_2O_3 coatings according to the invention are dense and free of microporosity and crystallographic defects. This is in contrast to previous reports on α-alumina coatings.”

78. There are then five examples. It is only necessary for present purposes to consider Example 1, since neither side suggests that Examples 2-5 add anything material.

79. Example 1 describes the manufacture of three types of insert, A, B and C. A is made in accordance with the invention, while B and C are made in accordance with unspecified prior art techniques. The process for making A consists of two steps: the nucleation step 1 which is according to the invention, and the deposition step 2, which is conventional and not according to the invention. These are described as follows (page 3 line 43 – page 4 line 7):

> “Cemented carbide cutting inserts with the composition 5.5 % Co, 8.5 % cubic carbides and balance WC were coated with a 5 μm thick layer of TiCN. In subsequent process steps during the same coating cycle, a fine grained (1-2 μm), 7 μm thick layer of α-Al_2O_3 was deposited. The oxidation potential of the hydrogen

carrier gas, i.e. the water vapour concentration, was explicitly set forth to a relatively low level, 10 ppm, prior to and during the Al_2O_3-nucleation. …

A reaction gas mixture comprising CO_2, CO, and Al_2O_3 was sequentially added to the hydrogen carrier gas in given order.

The gas mixtures and other process conditions during the Al_2O_3 deposition steps comprised:

1.		2. (not in accordance with the invention)	
CO_2: $AlCl_3$: CO: H_2:	4% 4% 2% balance	CO_2: $AlCl_3$: H_2S: H_2:	4% 4% 0.2% balance

1.		2. (not in accordance with the invention)	
Process pressure: Temperature: Duration:	6500 Pa (65 mbar) 1000°C 1 hr	Process pressure: Temperature: Duration:	6500 Pa (65 mbar) 1030°C 5.5 hr

”

80. The specification states that “XRD-analysis showed a texture coefficient, TC(012), of 2.1 of the (012) planes in the single α-phase of the Al_2O_3-coating”. It does not, however, give the underlying XRD data from which the figure of 2.1 has been calculated or explain how the underlying data were obtained.

81. The inserts are then tested with respect to edge line and rake face flaking. The results quoted are as follows:

“

	Flaking (%)	
	Edge line	Rake face
A) single phase/textured α-Al_2O_3 (acc. to the inv.)	0	0
B) α/κ Al_2O_3	40	5
C) κ-Al_2O_3	15	45

”

82. Neither in Example 1 nor in the other examples is there any comparison between single phase textured α-Al_2O_3 cutting tools according to the invention and other α-Al_2O_3 cutting tools, and in particular α-Al_2O_3 cutting tools with either no texture or a different texture.

The claims

83. With the correction of an obvious typographical error and broken down into integers, claim 1 is follows:

"[1] Body at least partially coated with one or more refractory layers of which at least one layer is alumina,

[2] said alumina layer having a thickness of d= 0.5-25 µm

[3] and consisting of single phase α-structure

[4] having a grain size(s):

0.5 µm < s < 1 µm for 0.5 µm < d < 2.5 µm

and

0.5 µm < s < 3 µm for 2.5 µm < d < 25 µm

characterized in that

[5] said alumina exhibits a texture coefficient (TC) larger than 1.3, preferably larger than 1.5, for the (012) growth direction of the equivalent crystallographic planes defined as:

$$TC(012) = \frac{I(012)}{I_o(012)} \left\{ \frac{1}{n} \sum \frac{I(hkl)}{I_o(hkl)} \right\}^{-1}$$

where

I(hkl) = measured intensity of the (hkl) reflection

I_0(hkl) = standard intensity of the ASTM standard powder pattern diffraction data

n = number of reflections used in the calculation (hkl) reflections used are: (012), (104), (110), (113), (024), (116)."

84. It will be noted that integer [5] of claim 1 embraces two alternatives, namely "larger than 1.3" and "larger than 1.5". Sandvik maintains that the claim with the lower limit is valid, but in the alternative contends that the claim with the higher is valid even if the claim with the lower limit lacks novelty or is obvious. Accordingly, it has conditionally applied to amend claim 1 to delete the words "larger than 1.3, preferably", thereby restricting the claim to larger than 1.5.

85. Claim 4 is as follows:

"Body according to any of the preceding claims **characterized** in that said alumina layer is in contact with a $TiC_xN_yO_z$ layer"

86. Claim 6 is as follows:

> "Body according to any of the preceding claims **characterized** in that said body is a cutting tool insert of cemented carbide, titanium based carbonitride or ceramics."

87. Broken down into integers, claim 7 is as follows:

> "[1] Method of coating a body with an alpha-alumina (Al_2O_3) layer according to claim 1 or 2
>
> [2] at which the body is brought into contact with a hydrogen carrier gas containing one or more halides of aluminium and a hydrolyzing and/or oxidizing agent at high temperature
>
> **characterized** in that
>
> [3] the water vapour concentration in the hydrogen carrier gas is below 20ppm prior to the nucleation of Al_2O_3 and that
>
> [4] the nucleation of Al_2O_3 is started up by sequencing the reactant gases in the following order: CO_2, CO and $AlCl_3$ and that
>
> [5] the temperature is about 1000^{o}C during the nucleation."

88. Sandvik relies on claim 6 as dependent on claim 4 as dependent on claim 1 as being independently valid in relation to some of Kennametal's insufficiency allegations, and it relies on claim 7 as being independently valid in relation to Kennametal's allegations of lack of novelty and obviousness. Sandvik alleges that Kennametal has infringed claims 1, 4 and 6, but not claim 7.

<u>Construction</u>

89. In *Virgin Atlantic Airways Ltd v Premium Aircraft Interiors UK Ltd* [2009] EWCA Civ 1062, [2010] RPC 8 at [5] the Court of Appeal summarised the general principles applicable to the construction of patent claims as follows:

> "One might have thought there was nothing more to say on this topic after *Kirin-Amgen Inc v Hoechst Marion Roussel Ltd* [2005] RPC 9. The judge accurately set out the position, save that he used the old language of Art.69 EPC rather than that of the EPC 2000, a Convention now in force. The new language omits 'the terms of' from Art.69. No one suggested the amendment changes the meaning. We set out what the judge said, but using the language of the EPC 2000:
>
> [182] The task for the court is to determine what the person skilled in the art would have understood the patentee to have been using the language of the claim to mean. The principles were summarised by Jacob LJ in *Mayne Pharma Pty Ltd v Pharmacia Italia SpA* [2005] EWCA Civ 137 and refined by Pumfrey J in *Halliburton Energy Services Inc v Smith International (North Sea) Ltd* [2005] EWHC 1623 (Pat) following their general

approval by the House of Lords in *Kirin-Amgen Inc v Hoechst Marion Roussel Ltd* [2005] RPC 9. An abbreviated version of them is as follows:

(i) The first overarching principle is that contained in Article 69 of the European Patent Convention.

(ii) Article 69 says that the extent of protection is determined by the claims. It goes on to say that the description and drawings shall be used to interpret the claims. In short the claims are to be construed in context.

(iii) It follows that the claims are to be construed purposively - the inventor's purpose being ascertained from the description and drawings.

(iv) It further follows that the claims must not be construed as if they stood alone - the drawings and description only being used to resolve any ambiguity. Purpose is vital to the construction of claims.

(v) When ascertaining the inventor's purpose, it must be remembered that he may have several purposes depending on the level of generality of his invention. Typically, for instance, an inventor may have one, generally more than one, specific embodiment as well as a generalised concept. But there is no presumption that the patentee necessarily intended the widest possible meaning consistent with his purpose be given to the words that he used: purpose and meaning are different.

(vi) Thus purpose is not the be-all and end-all. One is still at the end of the day concerned with the meaning of the language used. Hence the other extreme of the Protocol - a mere guideline - is also ruled out by Article 69 itself. It is the terms of the claims which delineate the patentee's territory.

(vii) It follows that if the patentee has included what is obviously a deliberate limitation in his claims, it must have a meaning. One cannot disregard obviously intentional elements.

(viii) It also follows that where a patentee has used a word or phrase which, acontextually, might have a particular meaning (narrow or wide) it does not necessarily have that meaning in context.

(ix) It further follows that there is no general 'doctrine of equivalents.'

(x) On the other hand purposive construction can lead to the conclusion that a technically trivial or minor difference between an element of a claim and the corresponding element of the alleged infringement nonetheless falls within the meaning of the element when read purposively. This is not because there is a doctrine of equivalents: it is because that is the fair way to read the claim in context.

(xi) Finally purposive construction leads one to eschew the kind of meticulous verbal analysis which lawyers are too often tempted by their training to indulge."

90. The Court of Appeal went on at [6]-[22] to hold that the skilled reader is to be taken to know the purpose of (i) including reference numerals in patent claims, (ii) dividing claims into pre-characterising and characterising portions and (iii) filing of divisional applications, and to bring that knowledge to bear when he considers the scope of the claim.

91. There are two issues of construction of claim 1.

Consisting of single phase α-structure

92. Kennametal contend that this means that only the α-phase of alumina must be present, to the exclusion of both any other crystalline phase and amorphous alumina. In support of this construction, Kennametal rely on the following points:

i) Dr James accepted that the word "phase" was apt to describe amorphous alumina and the contrary proposition was not put to Professor Bull.

ii) The specification excludes the presence of phases of alumina other than α, but only explicitly mentions some of them (at page 2 line 16, quoted in paragraph 68 above). It does not mention the δ, η or χ phases which the skilled person would be aware of.

iii) Dr James accepted that the skilled person would appreciate that the presence of amorphous alumina could be detrimental because it is softer.

93. Sandvik contends that the claim does not exclude the presence of amorphous alumina. In support of this Sandvik relies on the following points:

i) The Patent only refers to crystalline phases (see page 2 line 17, quoted in paragraph 68 above). Nowhere does it mention amorphous alumina.

ii) The purpose of the limitation to single phase α-alumina is, so Sandvik contends, to distinguish κ-alumina and mixed κ/α-alumina.

iii) Professor Bull accepted that the skilled person would appreciate dense, fine-grained alumina layers were bound to include some amorphous alumina at the grain boundaries.

iv) Example 1 of the Patent teaches wet-blasting the insert after coating to produce a smooth surface (page 4 line 20), and so the skilled person would not consider that production of some amorphous alumina as a result took the product outside the claim.

94. In relation to Sandvik's third point, Kennametal accept that the skilled person would not interpret the claim as excluding the presence of small quantities of amorphous alumina which were inevitably present at the grain boundaries, but contend that the skilled person would interpret the claim as excluding larger quantities of alumina which were detectable by XRD analysis.

95. In my view these arguments are finely balanced. With some hesitation, I have concluded that Kennametal's arguments are more persuasive. I therefore adopt Kennametal's construction.

A texture coefficient (TC) larger than 1.3, preferably larger than 1.5

96. By the end of the trial there was no dispute as to the effect of the numerical limits. It is common ground that a TC(012) of 1.29 is outside, while a TC(012) of 1.31 is inside, the 1.3 limit. Similarly, a TC(012) of 1.49 is without, while a TC(012) of 1.51 is within, the 1.5 limit. I have therefore put my own scepticism about this on one side.

97. The dispute is as to how the TC(012) is to be determined. The specification and the claim both set out the Harris formula. This involves a comparison between the measured intensity and the "standard intensity of the ASTM standard powder pattern diffraction data". As noted above, the specification does not identify which standard data (i.e. which PDF card) to use, nor does it describe the manner in which the XRD analysis is to be carried out. Thus it does not stipulate whether or not the skilled reader should carry out Kα2 stripping or a thin film correction. Kennametal contend that as a result this feature of claim 1 is ambiguous, and hence the Patent is insufficient.

98. A similar issue arose in *Lubrizol Corp v Esso Petroleum Co Ltd* [1998] RPC 727. In that case one feature of claim 1 required the polyalkene (in the embodiments which mattered, a polyisobutene or PIB) to have an Mn (number average molecular weight) value of 1300 to 5000. At the date of the patent in suit, it was known that the most accurate method for determining Mn was vapour phase osmometry (VPO), but it was time-consuming and difficult. The specification stated the Mn (and Mw, weight average molecular weight) value was to be determined by gel permeation chromatography (GPC) using a series of calibration standards of polymers of known molecular weight distribution. The defendants argued that the claim was ambiguous for two reasons, the first of which was that the specification did not state whether or not a refractive index correction should be made or not and therefore some skilled persons would make such a correction and some would not.

99. The Court of Appeal rejected this argument for reasons which Aldous LJ explained as follows at 750-754:

> "It is for the Court to construe the specification, but to do so it must adopt the mantle of the notional skilled man. In this case, that is particularly important as RI correction is not mentioned in the specification. If it did not form part of the common general knowledge, it could not form part of the way of determining the value of Mn indicated in the specification.
>
> The judge made certain findings of fact, but did not decide whether RI correction was part of the common general knowledge. It is therefore necessary to review the evidence on the matter.
>
> …
>
> The evidence did not establish that RI correction formed part of the common general knowledge at the time. In fact I believe the evidence established the contrary. … In general, persons who knew how to use GPC machines never corrected for RI divergence and it would not immediately have sprung to their mind that there was any need to do so. If they needed an accurate Mn measurement, VPO would be used. If GPC was to be used to obtain a measurement equivalent in accuracy to that derived using VPO then a correction, perhaps RI correction, would be considered. However as Dr Sims pointed out a GPC determination without RI correction produced an answer which was considered to be sufficient for the purposes of BP. That I believe was the stance taken by the specification. I believe the passage on page 5 of the specification, construed through the eyes of the notional skilled man, teaches that Mn and Mw values should be obtained using standard GPC techniques. RI correction is not mentioned …. The reader, if he thought about the effect of RI divergence, was entitled and right to conclude that the patentee must have known that the way to determine Mn using RI correction would not be known to the notional skilled man and therefore the patentee would have included appropriate instructions if he intended it to be carried out.
>
> The judge came to the wrong conclusion because he approached the issue incorrectly. The correct approach was to ask – What is the specification teaching? To answer that question it was necessary to put on the mantle of the notional skilled man and, having done so, to construe the passage on page 5 of the specification. The judge did not do that. He concluded, relying on the evidence of the witnesses called, that some people who were skilled in the art would use RI correction and some would not. Such people differed in experience and would have particular reasons which would cause them to act in a particular way. They would be skilled in

> the art, but not necessarily equivalent to the notional skilled addressee who only possessed common general knowledge."

100. So far as the thin film correction is concerned, counsel for Sandvik submitted that the situation in the present case was precisely analogous to the RI correction in *Lubrizol*. I agree with this. The specification does not state that a thin film correction should be carried out. It follows that a thin film correction should only be applied if the application of such a correction was common general knowledge. If it was common general knowledge, the draftsman was entitled to assume that the skilled reader would apply such a correction as a matter of routine without being told. If it was not common general knowledge, the draftsman was entitled to assume that the skilled reader would not apply such a correction unless he was instructed to. Furthermore, in that event the skilled reader who was aware of the possibility of making a thin film correction would conclude that the Patent must have been drafted on that assumption. I have concluded that it was not common general knowledge that a thin film correction should be applied. It follows that the correct interpretation of the Patent is that it should not be applied.

101. So far as Kα2 stripping is concerned, counsel for Sandvik submitted that the skilled person would do this, in particular because the 10-0173 and 42-1468 PDF cards contain Kα1 measurements. I do not accept this. The issue again is how the skilled reader would interpret the specification in the light of his or her common general knowledge, but here the situation is the reverse of that in *Lubrizol*: the specification does not state that the correction should be carried out, but the patentee contends that it would be done as a matter of common general knowledge. I have concluded, however, that in the absence of an explicit direction some skilled persons applying the common general knowledge would carry out Kα2 stripping, some would not and some would use their judgment on a case by case basis. It follows that some skilled persons reading the Patent in the light of the common general knowledge would do it, some would not and some would do it some of the time.

102. As to the PDF cards, the position is similar. Counsel for Sandvik advanced three alternative constructions of the claim. The first is that it calls for use of the 10-0173 card. The second is that it calls for use of the 42-1468 card. The third is that it calls for the TC(012) to be higher than 1.3 or 1.5 by reference to both cards. Since use of the 42-1468 card gives higher TC(012) values, this has the same effect as the first construction. In support of these alternative constructions, counsel for Sandvik relied upon the Protocol to Article 69 EPC, which requires the court to adopt a construction which provides reasonable certainty for third parties. He argued that it followed that the court should give the claim a fixed and clear meaning.

103. I do not accept this argument. I do accept that the court must attempt to construe the claim even if (as not infrequently happens) its meaning is unclear. I also accept that the construction it adopts should steer a middle course between providing fair protection for the patentee and reasonable certainty for third parties. But it does not follow that, if the claim is genuinely ambiguous when read in the light of the skilled person's common general knowledge, the court must select one meaning in order to cure the ambiguity.

104. In the present case some skilled persons reading the Patent in the light of the common general knowledge would use the 42-1468 card without being aware of an alternative

possibility, some would use the 10-0173 card without being aware of an alternative possibility, some would select the 10-0173 card as a matter of routine choice and some would be left to wonder which card the patentee intended them to use. In my view the last group would be left in a real quandary as to the correct answer.

105. For the reasons given above, I conclude that claim 1 is ambiguous. I will address the consequences of this below. I note that the Düsseldorf Court did not address this issue, because the choice of PDF card and carrying out Kα2 stripping made no difference to the infringement issues before it (see pages 35, 37, 39 and 43 of the judgment), and it was not concerned with validity.

Insufficiency: the law

106. A patent is invalid "if the specification does not disclose the invention clearly enough and completely enough for it to be performed by a person skilled in the art" (section 72(1)(c) of the 1977 Act). The patent will be insufficient if the skilled person is unable to carry out the claimed invention given the description of it in the specification and common general knowledge (sometimes called "classical insufficiency").

107. Unlike section 32(1)(i) of the Patents Act 1949, the 1977 Act does not provide that it is a ground of invalidity that "the scope of any claim of the complete specification is not sufficiently and clearly defined or that any claim of the complete specification is not fairly based on the matter disclosed in the specification". This is because no such ground is provided for by the European Patent Convention. Nor has the position changed in this respect following the coming into force of EPC 2000. This has given rise to repeated attempts by parties seeking to revoke patents to argue that a patent may be invalid on the ground of insufficiency as a result of either ambiguity or excessive breadth of the claims, rather than a result of classical insufficiency.

108. In the present case Kennametal contend that the Patent is insufficient in all three ways. It is therefore necessary to consider the law in some detail.

Classical insufficiency

109. In *Mentor Corp v Hollister Inc* [1991] FSR 557 at 162 Aldous J held:

> "The section requires the skilled man to be able to perform the invention, but does not lay down the limits as to the time and energy that the skilled man must spend seeking to perform the invention before it is insufficient. Clearly there must be a limit. The sub-section, by using the words, clearly enough and completely enough, contemplates that patent specifications need not set out every detail necessary for performance, but can leave the skilled man to use his skill to perform the invention. In so doing he must seek success. He should not be required to carry out any prolonged research, enquiry or experiment. He may need to carry out the ordinary methods of trial and error, which involve no inventive step and generally are necessary in applying the particular discovery to produce a practical result. In each case, it is a question of fact, depending on the nature of

> the invention, as to whether the steps needed to perform the invention are ordinary steps of trial and error which a skilled man would realise would be necessary and normal to produce a practical result."

110. Aldous J went on to cite the following passage from the judgment of the Technical Board of Appeal of the European Patent Office in T 226/85 *Unilever/Stable bleaches* [1989] EPOR 18 at [8] of the reasons:

> "Even though a reasonable amount of trial and error is permissible when it comes to the sufficiency of disclosure in an unexplored field or—as it is in this case—where there are many technical difficulties, there must then be available adequate instructions in the specification or on the basis of common general knowledge which would lead the skilled person necessarily and directly towards success through the evaluation of initial failures or through an acceptable statistical expectation rate in case of random experiments.
>
> In the present appeal the sensitivity or inherent instability of the composition, or other unexplained circumstances are such that the skilled person can only reproduce the invention in a number of instances with some luck, if at all, in view of the unknown character of reasons which cause failure. For this reason, the patent is invalid in its entirety for not complying with the requirements of Article 83 EPC."

111. Aldous J commented:

> "In that passage the Board contemplated that some experimentation may be necessary to perform an invention, but they suggested that the skilled man in that case had to be able to achieve success by evaluation and statistical analysis. That I believe is consistent with the view that I have expressed that the skilled man must seek success and must be able to achieve it by only carrying out the ordinary experiments or trials that are generally necessary in applying discoveries of the type with which the patent is concerned."

112. In the Court of Appeal [1993] RPC 7 at 14 Lloyd LJ approved Aldous J's statement of the law without reservation. He also commented that he found *Unilever/Stable bleaches* helpful, but did not find it necessary to make further mention of it.

113. In *Evans Medical Ltd's Patent* [1998] RPC 517 at 536-537 Laddie J said:

> "It is not enough if the instructions are such that a number of equally qualified notional addressees can arrive at completely different end points, some within the scope of the claimed invention and some not. If reasonable addressees can come to different conclusions there is a conundrum as to which is right. That is not enablement. This view appears to be consistent with the

> approach of the Technical Board of Appeal of the EPO in *Unilever/Stable bleaches* (Decision T226/855) [1988] OJEPO 336, which was referred to with approval by Aldous J and the Court of Appeal in *Mentor Corp v. Hollister Inc.*"

114. *Unilever/Stable bleaches* continues to represent the settled approach of the Boards of Appeal, although it has been elaborated in subsequent cases: see *Case Law of the Boards of Appeal of the European Patent Office* (6^{th} ed) at 236-238. In his judgment in *Novartis AG v Johnson & Johnson Medical Ltd* [2010] EWCA Civ 1039, [2011] ECC 10 at [72]-[76] Jacob LJ cited passages from three more recent decisions of the Boards of Appeal.

115. The first is T 435/91 *Unilever/Detergents* (reported *sub nom Unilever/Hexagonal liquid crystal gel*) [1995] EPOR 314 (cited in *Case Law* at p. 238) at [2.2] of the reasons:

> "In the Board's judgment the criteria for determining the sufficiency of the disclosure are the same for all inventions, irrespective of the way in which they are defined, be it by way of structural terms of their technical features or by their function. In both cases the requirement of sufficient disclosure can only mean that the whole subject-matter that is defined in the claims, and not only a part of it, must be capable of being carried out by the skilled person without the burden of an undue amount of experimentation or the application of inventive ingenuity.
>
> The peculiarity of the 'functional' definition of a component of a composition of matter resides in the fact that this component is not characterised in structural terms, but by means of its effect. Thus this mode of definition does not relate to a tangible component or group of components, but comprises an indefinite and abstract host of possible alternatives, which may have quite different chemical compositions, as long as they achieve the desired result. Consequently, they must all be available to the skilled person if the definition, and the claim of which it forms a part, is to meet the requirements of Article 83 or 100(b) EPC.
>
> This approach is based on the general legal principle that the protection covered by a patent should correspond to the technical contribution to the art made by the disclosure of the invention described therein, which excludes that the patent monopoly be extended to subject-matter which, after reading the patent specification, would still not be at the disposal of the skilled person.…
>
> There cannot, of course, be a clear-cut answer to the question of how many details in a specification are required in order to allow its reduction to practice within the comprehensive whole ambit of the claim, since this question can only be decided on

> the basis of the facts of each individual case. Nevertheless, it is clear that the available information must enable the skilled person to achieve the envisaged result within the whole ambit of the claim containing the respective 'functional" definition without undue difficulty, and that therefore the description with or without the relevant common general knowledge must provide a fully self-sufficient technical concept as to how this result is to be achieved."

116. The second is T 694/92 *Mycogen/Modifying plant cells* [1998] EPOR 114 (not T 494/92 *Mycogen/Plant gene expression* as stated in *Novartis v Johnson & Johnson*; not cited in *Case Law* in this context even though it is a decision of a five-person Board published in the Official Journal) at [5] of the reasons:

> "**Article 83 EPC** requires an invention to be disclosed in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art. As made clear in T 409/91 (OJ EPO 1994, 653, see in particular points 3.3 to 3.5 of the Reasons), the extent to which an invention is sufficiently disclosed is highly relevant when considering the issue of support within the meaning of Article 84 EPC, because both these requirements reflect the same general principle, namely that the scope of a granted patent should correspond to its technical contribution to the state of the art.
>
> Hence it follows that, despite being supported by the description from a purely formal point of view, claims may not be considered allowable if they encompass subject-matter which in the light of the disclosure provided by the description can be performed only with undue burden or with application of inventive skill. As for the amount of technical detail needed for a sufficient disclosure, this is a matter which depends on the correlation of the facts of each particular case with certain general parameters, such as the character of the technical field, the date on which the disclosure was presented and the corresponding common general knowledge, and the amount of reliable technical detail disclosed in a document (see decision T 158/91 of 30 July 1991).
>
> In certain cases a description of one way of performing the claimed invention may be sufficient to support broad claims with functionally defined features, for example where the disclosure of a new technique constitutes the essence of the invention and the description of **one way** of carrying it out enables the skilled person to obtain without undue burden the same effect of the invention in a broad area by use of suitable variants of the component features (see T 292/85 above). In other cases, more technical details and **more than one example** may be necessary in order to support claims of a broad scope, for example where the achievement of a given technical effect by known techniques in different areas of application

> constitutes the essence of the invention and serious doubts exist as to whether the said effect can readily be obtained for the whole range of applications claimed (see T 612/92 of 28 February 1996). However, in all these cases, the guiding principle is always that the skilled person should, after reading of the description, be able to readily perform the invention over the whole area claimed without undue burden and without needing inventive skill (see T 409/91 and T 435/91 above). On the other hand, the objection of lack of sufficient disclosure presupposes that there are serious doubts, substantiated by verifiable facts, in this respect, see T 19/90 (OJ EPO 1990, 476, see point 3.3 of the Reasons)."

117. The third is T 1743/06 *Ineos/Amorphous silica* (unreported; not cited in *Case Law*):

> "1.8 The appellant argued in this respect that the determination of the optimal stirring speed in the preparation of the silica claimed would be arrived at without undue burden simply by varying the stirring speed during the reaction of silicate with sulphuric acid while reworking the two examples of the patent specification.
>
> The board can accept that such a trial and error experimentation might in the present case not be considered as undue burden as far as the silicas illustrated in the examples of the contested patent are concerned. However, this reasoning which can be accepted only for the two examples, does not hold good for the other claimed but non-exemplified amorphous silicas and in the absence of any specific recipe concerning the preparation of such silicas, the problems concerning the stirring speed still remain for silicas claimed over the whole range.
>
> 1.9 The skilled person is thus confronted with the uncontested fact that he has a lot of process variables affecting the claimed parameters, but once he has encountered failure in one parameter value, there is no clear guidance enabling him to adjust the multitude of process steps in order to arrive with certitude at silicas meeting the parameter requirements defined in claim 1 of both requests at issue. Even though a reasonable amount of trial and error is permissible when it comes to assessing sufficiency of disclosure, there must still be adequate instructions in the specification, or on the basis of common general knowledge, leading the skilled person necessarily and directly towards success, through evaluation of initial failures. This is not the case here, since the preparation of the amorphous silicas claimed is made dependent on the adjustment of different process parameters for which no guidance is given in the patent in suit, so that the broad definition of an amorphous silica as presently claimed is no more than an invitation to perform a research program in order

> to find a suitable way of preparing the amorphous silicas over the whole area claimed.
>
> 1.10 It follows from the above, that the principle underlying Article 83 EPC that the skilled person should be given sufficient guidance for performing the invention without undue burden over the whole range claimed is thus not fulfilled."

118. Jacob LJ summarised the position in *Novartis v Johnson & Johnson* at [74] as follows:

> "The heart of the test is: 'Can the skilled person readily perform the invention over the whole area claimed without undue burden and without needing inventive skill?'"

On the facts, he agreed with counsel for Johnson & Johnson at [77] that the patent in suit "did no more than invite the reader to perform a research program where, if he succeeded, the patent claimed the fruits of his research".

Ambiguity

119. In *Kirin-Amgen Inc v Hoechst Marion Roussel Ltd* [2004] UKHL 46, [2005] RPC 9 claim 19 purported to distinguish the rEPO product falling within it on the basis that it had a "higher molecular weight by SDS-PAGE from erythropoietin isolated from urinary sources". SDS-PAGE was a well known method of ascertaining the apparent molecular weight of a protein. The specification did not, however, identify the uEPO which was to be used as the comparator. The House of Lords held that claim 19 was invalid for insufficiency as a result. As Lord Hoffmann explained:

> "124. The claim appeared to assume that all uEPOs had effectively the same molecular weight, irrespective of source and method of isolation. This had been shown not to be the case. So which uEPO did the claim require to be used for the test? Simply to use the first uEPO which came to hand would turn the claim into a lottery. On the other hand, it would be burdensome to have to work one's way through several specimens of uEPO (which were, as I mentioned at the beginning of my speech, extremely hard to come by) and even then the result would be inconclusive because *non constat* that some untried specimen did not have a different molecular weight.
>
> 125. The judge decided that the lack of clarity made the specification insufficient. It did not merely throw up the possibility of doubtful cases but made it impossible to determine in any case whether the product fell within the claim. The invention was not disclosed 'clearly enough and completely enough for it to be performed by a person skilled in the art': s.72(1)(c).
>
> 126. The Court of Appeal disagreed. They said that it was sufficient that some uEPO could be tested against eEPO by SDS-PAGE.

> The fact that it did not specify which uEPO and that choosing one uEPO would bring the product within the claim and another would not was 'lack of clarity dressed up to look like insufficiency.' For my part, I do not think that can be right. If the claim says that you must use an acid, and there is nothing in the specification or context to tell you which acid, and the invention will work with some acids but not with others but finding out which ones work will need extensive experiments, then that in my opinion is not merely lack of clarity; it is insufficiency. The lack of clarity does not merely create a fuzzy boundary between that which will work and that which will not. It makes it impossible to work the invention at all until one has found out what ingredient is needed."

120. In *SmithKline Beecham plc v Apotex Europe Ltd* [2004] EWCA Civ 1568, [2005] FSR 23 at [115] Jacob LJ recorded the following argument of Apotex as having "considerable force" although he did not decide it:

> "(5) It would seem to follow, if points (3)–(4) are accepted, that the meaning of the words 'solvate" and 'anhydrate' are truly ambiguous—are words which do not just have a 'fuzzy boundary" (*per* Lord Hoffmann in *Kirin-Amgen* ([126]). One just does not know what the patentee meant at all. If this logic is right, then not only can there be no infringement … but the claims would be truly ambiguous and thus insufficient on the principles laid down by Lord Hoffmann in *Kirin-Amgen*."

Excessive claim breadth

121. I recently reviewed the authorities on this topic, and in particular the decisions of the House of Lords in *Biogen Inc v Medeva plc* [1997] RPC 49, *Kirin-Amgen v Hoechst* and *Generics (UK) Ltd v H. Lundbeck A/S* [2009] UKHL 12, [2009] RPC 13, at length in *MedImmune Ltd v Novartis Pharmaceuticals UK Ltd* [2011] EWHC 1669 (Pat) at [459]-[484]. For convenience, I shall briefly repeat the main points of that analysis.

122. The main points which I drew from Lord Hoffmann's opinion in *Biogen v Medeva* were as follows:

i) A claim will be invalid for insufficiency if the breadth of the claim exceeds the technical contribution to the art made by the invention. It follows that it is not necessarily enough to disclose one way of performing the invention in the specification.

ii) The breadth of the claim will exceed the technical contribution if the claim covers ways of achieving the desired result which owe nothing to the patent or any principle it discloses. Two classes of this are where the patent claims results which it does not enable, such as making a wider class of products when it enables only one and discloses no principle to enable the others to be made, and where the patent claims every way of achieving a result when it enables only one way and it is possible to envisage other ways of achieving that result which make no use of the invention.

iii) The patent in *Biogen v Medeva* was invalid because it was an example of the second class of objectionable claim.

123. The key point which emerges from Lord Hoffmann's opinion in *Kirin-Amgen v Hoechst* is his explanation at [112] of what he had meant by "a principle of general application" in *Biogen v Medeva*:

> "In my opinion there is nothing difficult or mysterious about it. It simply means an element of the claim which is stated in general terms. Such a claim is sufficiently enabled if one can reasonably expect the invention to work with anything which falls within the general term."

124. I summarised the reasoning of the House in *Generics v Lundbeck* as follows:

i) The House agreed with Lord Hoffmann in *Biogen v Medeva* that it was important for United Kingdom patent law to be aligned, so far as possible, with the jurisprudence of the EPO. Furthermore, the House also agreed with Lord Hoffmann that the statement of principle which he quoted from *Exxon/Fuel oils* correctly stated the law.

ii) The House considered that the instant case was to be distinguished from *Biogen v Medeva* because it was concerned with a claim to a single chemical compound whereas *Biogen v Medeva* concerned a product-by-process claim of broad scope.

iii) It was a mistake to equate the technical contribution of the claim with its inventive concept. In the instant case, the technical contribution made by claims 1 and 3 was the product, and not the process by which it was made, even though the inventive step lay in finding a way to make the product. It followed that the breadth of the claim did not exceed the technical contribution which the invention made to the art.

Insufficiency: the facts

125. In its skeleton argument and written closing submissions, Kennametal presented its case of insufficiency under six different headings. As I have already observed, these involve contentions that the Patent is insufficient in all three ways discussed above.

Classical insufficiency

126. *Reproducibility of Example 1*. The starting point for the inquiry here is to ask whether the skilled person would be able, following the instructions given in Example 1 of the specification and using his common general knowledge, to produce a product falling within claim 1 without undue burden and without inventive skill. To answer this question, both parties performed experiments in which they purported to reproduce the preparation of insert A in Example 1. The results, in short, were that Sandvik produced inserts all of which fell within the claim in the experiments reported in the notice and the majority of which fell within the claim in the repeats, while Kennametal produced inserts none of which fell within the claim.

127. *Kennametal's experiment*. This was designed by Dr Helga Holzschuh of SuCoTec AG, a Swiss independent testing laboratory, although the experiment was performed at Kennametal's premises in Latrobe, Pennsylvania. Unusually, the notice of experiments took the form of a report by Dr Holzschuh in which she not only described the experiment and the results obtained, but also described her own qualifications to undertake the work. She obtained a Pre-Diploma and Diploma from the University of Tübingen between 1981 and 1987. In 1991 she obtained a Doctorate from the same university on Plasma-activated Deposition of Yttrium-, Barium-, Copper- and Zirconium Oxides. She was a post-doctoral student at the same university from 1990 to 1994, after which she spent 15 years working for Walter AG as Manager of Research and Development of CVD Coating Technology, focussing on the development of wear resistant coatings for cutting tool applications, including CVD deposition of Al_2O_3. As well as being a Consultant for SuCoTec in the same field, she is an Associate Professor at the University of Albstadt.

128. Although Dr Holzschuh designed the experiment, she has not given evidence in these proceedings to explain her thought processes beyond what is stated in her report. Her experiment was approved by Professor Bull, but only after the event. He also attended the repetition of the experiment.

129. There is no dispute that the experiment failed to produce inserts with a TC(012) value within the claim. It consistently produced a preferred orientation in the (104) plane. Even with PDF card 42-1468, the highest TC (012) value obtained was 0.84.

130. Sandvik contends that this experiment did not accurately reproduce the conditions of Example 1. Dr James suggested in his first report that the experiment departed from Example 1 in the following respects:

i) The reactor used was a Bernex 325S NW, which could be used in an axial flow or radial flow mode. Dr Holzschuh had used the radial flow mode, whereas Dr James suggested that the specification implicitly required use of the axial flow mode. As he acknowledged in his second report, this was based on a mistake, but he nevertheless continued to suggest that use of the radial flow mode was inappropriate for other reasons.

ii) Dr James pointed out that Dr Holzschuh's report stated that "well-defined opening and closing times of the valves of the Bernex 325S NW requires a minimum process time of 0.5min". Dr James expressed the opinion that this was too long for the oxidation step, and that equipment capable of shorter process times should have been used.

iii) After deposition of a layer of TiCN using methane (CH_4), nitrogen (N_2), titanium tetrachloride ($TiCl_4$) and hydrogen, Dr Holzschuh had purged the reactor for 10 minutes with a mixture of nitrogen and hydrogen before depositing the Al_2O_3. Dr James expressed the opinion that nitrogen should not have been used for this purpose, and that it could have been responsible for the (104) texture obtained.

iv) The water content of the hydrogen was not measured during the repeat. Dr James said that the water content was a key feature of the process and that he would expect differences in the water content to have an effect on the texture of the coating. In fact this was another mistake, since the water content was measured, as I shall explain below.

131. In his closing submissions, counsel for Sandvik only pursued the third of these points. It is nevertheless significant that the other points were raised by Dr James in the first place. Example 1 does not specify what reactor should be used, whether it should be operated in axial flow or radial flow mode or how long the oxidation step should be. Furthermore, while it does specify the water content, neither side followed Example 1 in this respect. I will return to these points below.

132. So far as the use of nitrogen to purge is concerned, it is common ground that (a) Example 1 does not mention purging the reactor between depositing the TiCN and depositing the Al_2O_3, (b) it was common general knowledge that the reactor should be purged in order to remove the residual $TiCl_4$ from the TiCN step as this could interfere with the Al_2O_3 deposition and (c) hydrogen was a common gas to use for this purpose. This leaves the following issues: (i) was the use of nitrogen in accordance with common general knowledge, (ii) did it in fact have an effect on the texture and (iii) if it did have an effect, would the skilled person have appreciated that from his common general knowledge in December 1992?

133. So far as issue (i) is concerned, counsel for Sandvik relied on the fact that there is no documentary evidence of the use of nitrogen at the priority date, and in particular that the manual for the Bernex reactor used by Sandvik in its experiments (which is a different model to that used by Kennametal) only mentions hydrogen. Professor Bull's opinion, however, was that the inclusion of nitrogen was a reasonable choice since it would react with $TiCl_4$ to produce TiN and one that was in accordance with the common general knowledge. Dr James accepted this in cross-examination.

134. As to issue (ii), Dr James suggested that the presence of nitrogen could have been responsible for the (104) texture. This suggestion was based on work done by Sandvik long after 1992. In 1998 Sandvik obtained a US patent for cutting tools coated with a pure α-Al_2O_3 coating that exhibited texture in the (104) direction. The method identified in the patent to achieve this feature was to supply the CO_2 and CO into the reactor in a hydrogen-free atmosphere. The example given in that patent suggested supplying the CO_2 and CO in the presence of nitrogen and/or argon. Sandvik subsequently discovered that it was the presence of nitrogen rather than the absence of hydrogen at this stage of the process that resulted in the (104) texture. But it does not necessarily follow that it was the nitrogen that was responsible for this in the Kennametal experiment. As Professor Bull pointed out, in the Kennametal experiment the nitrogen was turned off before the first oxidation step and the time lag before the CO_2 arrived in the chamber should have meant that there was no nitrogen left by that point. Accordingly, Professor Bull thought that the inclusion of nitrogen in the purge gas was unlikely to have made a difference to the orientation, but he accepted that he was unable to tell one way or the other. In this regard, I note that Sandvik has not carried out an experiment in reply which replicates the Kennametal experiment except in this respect, nor did it request Kennametal to do this when repeating the experiment (which might have been more practical).

135. Turning to issue (iii), it is clear that the skilled person would not have appreciated from his common general knowledge that nitrogen was, or even might be, responsible

for the wrong texture being obtained. As I have already noted, even Sandvik did not became aware of the potential effect of nitrogen until long after the priority date.

136. Counsel for Sandvik submitted that this did not prove that the Patent was insufficient, because Dr Holzschuh does not appear to have made any attempt to evaluate how she might change her protocol to try to bring the results within the claim. Neither was Professor Bull asked how that might be done. Thus there was no "evaluation of initial failures" as required by *Unilever/Stable bleaches*. Counsel argued that the skilled person would realise that nitrogen was the one element present in the Kennametal experiment which was not present in Example 1, that it was therefore an obvious candidate for being the cause of the problem and that it would be an easy thing to change.

137. I do not accept this argument for two reasons. First, I do not accept the premise that the skilled person would realise that nitrogen was the one element present in the Kennametal experiment which was not present in Example 1. Example 1 does not describe purging the reactor at all. The skilled reader is therefore left to his common general knowledge to decide what to do. Given that use of nitrogen was in accordance with the common general knowledge, the skilled reader would not appreciate that he was doing something that he was not supposed to do.

138. Secondly, I do not accept the implicit suggestions that eliminating the use of nitrogen would be the first thing the skilled person would do or that it would do the trick. For the reasons I shall explain below, I consider that the skilled person would be faced with a number of other possibilities. Nor is it established that this one would work as I have already explained.

139. *Sandvik's experiment*. Sandvik's experiment was, subject to the points discussed below, designed by Dr James. He used a Bernex Manumat 200T reactor in an axial flow mode. There is no dispute that the experiment set out in the notice produced inserts with a TC(012) value within the claim or that the repeat produced inserts only the majority of which fell within the claim. On both occasions inserts on the higher trays in the reactor had a higher TC(012) than inserts in the lower trays. The reason for this is unclear, as is the explanation for the fact that the problem, whatever it was, seems to have been more pronounced during the repetition.

140. Kennametal contend that (i) this experiment did not accurately reproduce the conditions of Example 1, (ii) Dr James made certain choices which, albeit within the scope of Example 1, were not dictated by Example 1 and (iii) some of those choices were not even in accordance with the common general knowledge.

141. So far as point (i) is concerned, Example 1 states that a 7 µm layer of α-Al_2O_3 is deposited "in subsequent process steps during the same coating cycle" after the deposition of a 5 µm layer of TiCN (page 3 lines 43-45, quoted in paragraph 79 above). This is not what Sandvik did. Instead, Sandvik first pre-coated the inserts with TiCN in a separate cycle to a thickness of about 7 µm, then allowed them cool, then applied a thin "refresher" coating of TiCN and then deposited the α-Al_2O_3. In my judgment this does not accord with Example 1.

142. Inevitably, this departure gave rise to a dispute as to whether it would have made a difference to the TC(012) value. The short answer to this is that one cannot tell, since

Sandvik did not carry out an experiment in which the two steps were performed in the same coating cycle. (In Kennametal's experiment the two steps were performed in the same cycle.) Dr James' opinion was there was a low probability of it affecting the result, but he could not exclude this possibility. Professor Bull's evidence was that in his experience taking an insert out of the reactor and leaving it to cool in the atmosphere led to contamination on the surface. He explained that this could affect the refresher layer which in turn could effect the orientation of the alumina. Importantly, Kennametal requested during the repetition that one or two pre-coated samples be retained and not coated with alumina so as to enable Kennametal to undertake later analysis of them, but Sandvik refused this request. In my view this was a perfectly proper request and Sandvik was not justified in refusing it. In these circumstances, I do not consider that it is open to Sandvik to contend that the pre-coated surface could not have affected the orientation of the alumina.

143. As to point (ii), as I have already noted, Sandvik's experiment had the reactor set up in axial flow mode. Example 1 does not specify this. Dr James chose it because he knew that Sandvik's R&D facility was configured in this way in 1992. He thought that the skilled person would be aware of this, but in my judgment it has not been shown that this was common general knowledge. As noted above, Dr James' opinion was that this could make a difference to the result even though in theory it ought not to.

144. In addition, in Sandvik's experiment the CO_2 was introduced 5 seconds before the CO and the total oxidation time was 35 seconds. Although Dr James explained why he chose 5 seconds, it is not clear why he chose a total time of 35 seconds, although it appears to have been influenced by recent work done by Sandvik. In any event, neither time is specified in Example 1. Dr James' evidence was that this was an important parameter. He accepted that, even given that the skilled person would be aiming for a well-adherent coating, the effect of different times would have been completely unknown in 1992 and one could get "wildly varying" textures depending on the times chosen.

145. Point (iii) again concerns the pre-coating step. Dr James asked Sandvik's engineers for "a standard off-the-shelf recipe". It appears that the recipe they used was a production recipe used by Sandvik at the time i.e. in 2011. There is no evidence that this is the same as a skilled person operating in accordance with the common general knowledge would have used in 1992. Furthermore, Dr James specifically requested that the standard recipe be adjusted to have a higher nitrogen content. Again, there is no evidence that a skilled person operating in accordance with the common general knowledge would have requested this in 1992. Still further, Dr James followed the advice of the Sandvik technicians to carry out this step at high temperature. Yet the manual said by Sandvik to be the manual for the Bernex Manumat 200T reactor refers to this step being carried out at medium temperature. Again, there is no evidence that a skilled person operating in accordance with the common general knowledge would have made this change in 1992. Each of these factors could have affected the result for the reason explained by Professor Bull (see paragraph 142 above).

146. *Conclusion on Example 1*. The conclusion I draw from this evidence is that the skilled person would not be able, following the instructions given in Example 1 of the specification and using his common general knowledge, to produce a product falling within claim 1 without undue burden. Success would be far from guaranteed; a series

of factors which are not specified in Example 1 would be likely to affect the result; and if the skilled person did not achieve success first time he would not know what changes to make to achieve success. I will elaborate on the last point below.

147. This conclusion is consistent with evidence given by Mr Ljungberg in the US proceedings to the effect that Sandvik had not actually carried out Example 1 before filing the application for the Patent. Rather, he had "made an assumption". In other words, Example 1 is what is sometimes called an "armchair example". This in itself is no objection to the validity of the Patent; but it is not surprising that the example turns not to be easy to reproduce.

148. *Sufficiency across the breadth of claim 6*. Even if I had concluded that the skilled person could reproduce Example 1 without undue burden, in my judgment it is clear that the Patent does not enable the skilled person to perform the invention over the whole area claimed in claim 6 as dependent on claim 4 as dependent on claim 1 without undue burden and without inventive skill. I focus on this claim (which I will refer to simply as "claim 6" for short) since it represents the narrowest product claim defended by Sandvik.

149. The starting point here is the assertion made in the specification that "It is within the purview of the skilled artisan … to modify the deposition conditions in accordance with the present specification, if desired, to effect the amount of texture" (page 3 lines 35-37, quoted in paragraph 76 above). Dr James frankly admitted that this assertion was untrue: the Patent does not teach the skilled reader how to change the parameters to affect the texture and the skilled reader would have had no idea how to do this from his common general knowledge. Dr James himself explained that controlling the texture coefficient was a delicate process because the energy differences between the nucleation of different textures were miniscule.

150. Dr James' answer to the problem that this would pose the skilled person was telling:

> "Q. If you were an ordinary person in 1992 and you were given this patent to work with and you had a first stab at example 1 looking for a texture in the (012) direction of say 1.3, and it did not work, you would have absolutely no idea why not, would you?
>
> A. No, there is no conclusion you can draw from this that would drive you other than to do an experimental matrix and say 'What is the critical set of parameters?' and then do high/low and so on around it. That is a well-known and very efficient method of zeroing in process parameters.
>
> Q. It may be, but it is a tremendous amount of work, is it not?
>
> A. No, I mean, there are well-known ways of doing it and, you know, if you go through four or five repetitions you usually get very close."

151. Thus Dr James envisaged doing four or five repetitions of a matrix experiment (a design of experiment in which different experimental variables are combined in

accordance with a matrix, enabling a large number of permutations to be explored by a relatively small number of tests). Even on its face, this is a substantial amount of work. Moreover, it is clear that there are a considerable number of variables which the skilled person would have to include in his matrix. Some of these I have already discussed (axial or radial flow; the timing of the oxidation steps (i.e. the introduction of CO_2 and CO); the purge gases). Additional factors include the water content, the deposition time and the substrate.

152. It is common ground that control of the water content is important. In Example 1, the water content of the hydrogen was 10 ppm (page 3 line 46), but the general teaching of the specification is that it should be below 20 ppm, preferably below 5 ppm (page 3 line 32) and the limit in claim 7 is 20 ppm. In Kennametal's experiments the water content of the hydrogen was 0.73 ppm (notice) and 0.011 ppm (repeat) and the total water content in the reactor including leakage was below 2 ppm (notice) and below 5 ppm (repeat). Interestingly, Sandvik did not in the end contend that this factor meant that Kennametal's experiment was not in accordance with Example 1 even though it represents an apparent departure from the example. No doubt Sandvik was conscious that it had done the same thing: although, surprisingly, Sandvik did not actually measure the water content of the hydrogen, Dr James' evidence, based on his familiarity with the equipment used, was that it was less than 10 ppm, and probably less than 5 ppm. It follows that both parties kept within the lower limit suggested within the specification.

153. It is clear from Dr James' evidence, however, that he considered that a higher water content, and in particular higher than 10 ppm, could adversely affect the texture of the coating. This is supported by a paper by Ruppi (of Seco), "Deposition, microstructure and properties of texture-controlled CVD α-Al_2O_3", *Int. J. Refrac. Met. & Hard Mat.,* 23 (2005), 306-316. He deposited five α-alumina coatings (A-E) from an $AlCl_3$-CO_2-Ar-H_2-H_2S system at 1000^oC in a commercial CVD reactor. An important difference characterising the nucleation steps was the oxidation potential of the reactor atmosphere, which varied from about 5 ppm water (coating B) to about 20 ppm water (coating D). The TC results showed that coating B had a strong (012) texture, while coating D had almost none. The system is, of course, slightly different to the system used in Example 1, but nevertheless it illustrates the potential effect of higher water concentrations. There is nothing to suggest that the skilled reader of the Patent would think that the water content should be kept below 10 ppm.

154. As for the deposition time, as discussed above Example 1 has two steps, a nucleation step in accordance with the invention and a deposition step not in accordance with the invention. The second step lasts 5.5 hours, but there is nothing in the specification to suggest that this is a parameter which needs to be controlled. In his 2005 paper, however, Ruppi also investigated the effect of the deposition time, which was 560 minutes for coating C and 60 minutes for coating E. Again, this had an effect on the TC value, albeit in the (104) direction and a more modest one. As I shall discuss below, there is also evidence from Mr Ljungberg that Sandvik considers that the deposition time is an important parameter.

155. So far as the substrate is concerned, it is important to appreciate the width even of claim 6 as dependent on claim 4 as dependent on claim 1. Although claim 6 limits the extraordinary breadth of the "body" of claim 1 to a cutting tool insert of cemented carbide, titanium-based carbonitride or ceramics and claim 4 limits this still further to

a tool where the α-alumina is in contact with a $TiC_xN_yO_z$ layer, that still covers a wide range of substrates. The specification defines $TiC_xN_yO_z$ as meaning TiC and compositions in which "the carbon in TiC is completely or partly substituted by oxygen and/or nitrogen" (page 2 lines 25-26, quoted in paragraph 69 above). This includes TiCN, TiN, TiCO and at least TiO, if not other titanium oxides. It is clear, not least from the Chatfield Paper, that the choice of substrate will influence the nucleation of alumina and hence the texture obtained. In particular, as discussed above in relation to the use of nitrogen as a purge gas, it now appears that a nitrogen-enriched TiCN layer will lead to texture in the (104) direction.

156. Finally, it is important to emphasise that claim 6 is not restricted to nucleated α-alumina, but covers α-alumina which has been transformed from κ-alumina. The evidence suggests, however, that it is difficult to achieve texture in the (012) direction with transformed α-alumina. It should also be borne in mind that claim 6 embraces quite a range of grain sizes and thicknesses of the α-alumina layer.

157. These considerations mean that the specification does not begin to enable the skilled person to perform the invention across the width of claim 6. Rather, it is no more than an invitation to carry out a research programme in order to find a suitable way (or ways) of depositing α-alumina with a TC(012) of at least 1.3 over the area claimed, with Sandvik claiming the results of that programme.

158. This conclusion is supported by three pieces of evidence emanating from the US proceedings upon which Kennametal rely. First, in an internal Sandvik technical memo written on 27 October 1992, Mr Ljungberg reported the results of texture analysis of a number of samples of nucleated and transformed α-alumina coatings produced by Sandvik and α-alumina coatings produced by three competitors. The memo concluded:

> "We still have no indication as to [why] our new alpha-alumina has a preferential growth in the 012 direction. The reason for this may lie either the nucleation stage, or in the fact that the layer studied was relatively thick…"

Thus Sandvik did not know why they had obtained texture in the (012) direction. Indeed, Mr Ljungberg still did not know when deposed on 22 June 2011, apart from saying that the oxidation step and the growth conditions were both important. Furthermore, Appendix 3 to the memo shows that the TC(012) values for eight of Sandvik's α-alumina samples ranged from 0.58 to 2.34. Again, Mr Ljungberg was unable to explain this even in 2011.

159. Secondly, even after the application for the Patent had been filed, control of texture remained a mystery even to Sandvik. Mr Ljungberg was asked in his deposition about a report of TC results for Sandvik's GC4215 grade, which he summarised as follows:

> "… varying results was achieved. Brazil have inserts with 104 texture. Also Japanese have 104 texture, but 012 in the bottom of the charge. India had weak 104 and the 012 in the bottom. England showed strong 012 in the whole charge."

160. Thirdly, Mr Karlsson said in his deposition that controlling texture was a matter of trial and error and that even today there is no solid theory as to why "if you did this, that happens".

161. *Conclusion*. I therefore conclude that claim 6 is insufficient. It follows that claims 1 and 4 are insufficient as well. As counsel for Sandvik conceded, it also follows that claim 7 is insufficient since it is dependent on claim 1.

Ambiguity

162. Counsel for Sandvik conceded that the Patent was insufficient if integer [5] of claim 1 was ambiguous, and specifically if it was unclear to the skilled reader which PDF card to use. In the light of this concession I can deal with this topic briefly.

163. As counsel for Kennametal submitted, the choice of which PDF card to use and whether to carry out $K\alpha 2$ stripping both make a systematic difference to the TC(012) value one obtains. In the case of the PDF card, it makes a difference of about 0.1. In the case of $K\alpha 2$ stripping, it makes a difference of about 5-10%. Each of these differences is potentially material to infringement. Furthermore, they are potentially additive.

164. Although these effects will only make the difference between infringement and non-infringement for coatings which are reasonably close to the lower limit in integer [5], be it 1.3 or 1.5, in such circumstances it is impossible to say whether the product falls within the claim or not, because it is uncertain what the correct test is. Thus it is not merely a case of the claim having a fuzzy boundary. Accordingly, I consider that counsel for Sandvik was right to concede that in this event the Patent is insufficient.

165. I therefore conclude that the Patent is insufficient on this ground as well.

Excessive claim breadth

166. Counsel for Sandvik submitted that claim 6 was an "ordinary" product claim comparable to that under consideration in *Generics v Lundbeck* rather than a claim of the kind which was in issue in *Biogen v Medeva*. I do not accept this submission. As I have endeavoured to explain, in *Generics v Lundbeck* the House of Lords proceeded on the basis that the technical contribution made by the invention was the single product which was the subject of the claim. Accordingly, the breadth of the claim did not exceed the technical contribution, and it was neither here nor there that the specification only disclosed one way of making the product. In the present case, however, claim 6 covers a broad range of products as discussed above. Furthermore, the key characterising feature, integer [5] of claim 1, depends crucially upon the way in which the product is made.

167. The Patent claims that a cutting tool in accordance with the invention "exhibits improved wear and toughness properties compared to prior art tools" (page 2 lines 48-49, quoted in paragraph 74 above). Not only is there no evidence to suggest that all inserts falling within claim 6 deliver these advantages, but in fact the evidence is to the contrary effect as I shall discuss below.

168. Contrary to the submission of counsel for Kennametal, however, this on its own is not enough to make claim 6 insufficient. If the claim were not classically insufficient, it would be immaterial that the claim covered products some of which had useful properties and some which did not (although it would be relevant to the question of obviousness as discussed below). On the other hand, it seems to me that this point reinforces the objection of classical insufficiency: not only does the Patent present the skilled person with a research project and claim the results, but also the results may well not even be useful.

169. Thus I conclude that claim 6 is not insufficient for this reason alone, but that it reinforces the objection of classical insufficiency.

Lack of novelty

170. In his closing submissions, counsel for Kennametal only advanced lack of novelty as a squeeze on insufficiency. Since I have concluded that the Patent is insufficient, I can deal with this objection very briefly.

171. As was explained by the House of Lords in *Synthon BV v SmithKline Beecham plc* [2005] UKHL 59, [2006] RPC 10, in order for an item of prior art to deprive a patent claim of novelty, two requirements must be satisfied. First, the prior art must disclose subject matter which, if performed, would necessarily infringe that claim. Secondly, the prior art must disclose that subject matter sufficiently to enable the skilled addressee to perform it. The test for enablement in this context is essentially the same as the test for enablement in the context of insufficiency: see Lord Hoffmann at [27].

172. Kennametal carried out experiments on a series of samples of prior art cutting tools emanating from Sandvik and themselves. There is no dispute that at least some of the samples fell within claim 6, and that at least one exceeded the higher limit in integer [5] of claim 1. The only basis upon which Sandvik resisted the novelty attack was that the prior uses were not enabling. Counsel for Kennametal's argument was that the prior uses were no less enabling than the Patent. Since I have concluded that the Patent is insufficient, it follows that claim 6 is novel over the prior uses.

Obviousness

173. A patent will be invalid for lack of inventive step if the invention claimed in it was obvious to a person skilled in the art having regard to the state of the art at the priority date. The familiar structured approach to the assessment of allegations of obviousness first articulated by the Court of Appeal in *Windsurfing International Inc v Tabur Marine (Great Britain) Ltd* [1985] RPC 59 was re-stated by Jacob LJ in *Pozzoli v BDMO SA* [2007] EWCA Civ 588, [2007] FSR 37 at [23] as follows:

"(1)(a) Identify the notional 'person skilled in the art';

(b) Identify the relevant common general knowledge of that person;

(2) Identify the inventive concept of the claim in question or if that cannot readily be done, construe it;

(3) Identify what, if any, differences exist between the matter cited as forming part of the 'state of the art' and the inventive concept of the claim or the claim as construed;

(4) Viewed without any knowledge of the alleged invention as claimed, do those differences constitute steps which would have been obvious to the person skilled in the art or do they require any degree of invention?"

174. In both *H. Lundbeck A/S v Generics (UK) Ltd* [2008] EWCA Civ 311, [2008] RPC 19 at [24] and *Conor Medsystems Inc v Angiotech Pharmaceuticals Inc* [2008] UKHL 49, [2008] RPC 28 at [42] Lord Hoffmann approved without qualification the following statement of principle by Kitchin J at first instance in the former case:

> "The question of obviousness must be considered on the facts of each case. The court must consider the weight to be attached to any particular factor in the light of all the relevant circumstances. These may include such matters as the motive to find a solution to the problem the patent addresses, the number and extent of the possible avenues of research, the effort involved in pursuing them and the expectation of success."

The prior art relied upon

175. Kennametal contend that the Patent is obvious over Kim, the Chatfield Paper, the Chatfield Application and common general knowledge alone. I have described the disclosure of the Chatfield Paper in detail in paragraphs 28-33 above and that of Kim very briefly in paragraph 41 above. The disclosure of the Chatfield Application is summarised at page 3 line 51 – page 4 line 1 as follows:

> "According to the invention there is thus now available a body such as e.g. a cutting insert for chipforming machining coated with at least one layer of Al_2O_3 + TiC in which the Al_2O_3-layer is in epitaxial contact with adjacent TiC-layer and consists of kappa- or theta-Al_2O_3. In general the Al_2O_3-layer consists of at least 90 %, preferably at least 98 % alpha-Al_2O_3 which has been initially nucleated as kappa- or theta-Al_2O_3 and which has been obtained by a subsequent heat treatment. By this measure a dense and wear resistant alpha-Al_2O_3 is obtained which is fine-grained and has a good bond to the underlying TiC-, TiN- or TiO-layer. The fine grain size and the good bond are caused by the excellent nucleation properties of the initially nucleated kappa-Al_2O_3-layer. In said respect the invention can be described as alpha-Al_2O_3 with kappa-Al_2O_3-morphology."

176. Although counsel for Kennametal did not distinguish between these different starting points in his closing submissions, it seems to me that the Chatfield Application represents Kennametal's best starting point and that the other starting points add nothing material to its case. Although not explicitly identified as such in the Patent, the Chatfield Application was the basis for the pre-characterising portion of claim 1. I do not understand it to be disputed that the Chatfield Application discloses cutting

tools having the features of integers [1]-[4] of claim 1 and the additional features of claims 4 and 6.

Obviousness of claim 6

177. I have identified the skilled person and the common general knowledge above. The inventive concept of claim 6 is a cutting tool insert having the features of claims 1, 4 and 6. This may be summarised as an insert of cemented carbide etc coated with a $TiC_xN_yO_z$ layer coated with a layer of the specified thickness of fine grained (within the limits specified) of single phase α-alumina having a TC(012) larger than 1.3, alternatively larger than 1.5. The difference between this and what is disclosed in the Chatfield Application is that the claim requires the specified texture whereas the Chatfield Application does not disclose what texture, if any, the inserts have.

178. Counsel for Kennametal did not argue that anything in the Chatfield Application itself made it obvious to produce an insert with a TC(012) of larger than 1.3 or 1.5. Nor did he argue that it would be obvious from the skilled person's common general knowledge to aim for such a TC(012) value, although he did point out that (as is common ground) it would be obvious to the skilled person from his common general knowledge that in theory a preferred orientation in one direction might be beneficial. Instead he argued as follows:

i) In practice, a skilled person making α-alumina coated inserts would be likely to produce inserts with (among other orientations and none) a TC(012) of greater than 1.3, or even 1.5, as a matter of chance, since such a TC(012) value was not significantly different to a random orientation.

ii) The Patent did not make it plausible that having a TC(012) of greater than 1.3, or even 1.5, conferred any technical advantage, and the evidence before the Court was to the contrary effect.

iii) Accordingly, the claim was obvious because it was an arbitrary selection with no technical merit.

179. This argument gave rise to a lively dispute between counsel as to the law. In short, counsel for Sandvik submitted that an argument along these lines was only legitimate in the case of chemical compound selection patents, whereas counsel for Kennametal disputed this.

180. In the leading case of T 939/92 *Agrevo/Triazoles* [1996] EPOR 171, which concerned herbicides, the Technical Board of Appeal said:

> "2.4.2 … it has for long been a generally accepted legal principle that the extent of the patent monopoly should correspond to and be justified by the technical contribution to the art …. Now, whereas in both the above decisions this general legal principle was applied in relation to the extent of the patent protection that was justified by reference to the requirements of Articles 83 and 84 EPC, the same legal principle also governs the decision that is required to be made under Article 56 EPC, for everything falling within a valid claim has to be inventive. If this is

not the case, the claim must be amended so as to exclude the obvious subject-matter in order to justify the monopoly.

Moreover, in the Board's judgment, it follows from this same legal principle that the answer to the question what a skilled person would have done in the light of the state of the art depends in large measure on the technical result he had set out to achieve. In order words, the notional 'person skilled in the art' is not to be assumed to perform a particular act without some concrete technical reason; he must, rather, be assumed to act not out of idle curiosity but with some specific technical purpose in mind.

…

2.5.3 … The answer to the question as to what a person skilled in the art would have done depends on the result he wished to obtain, as explained in point 2.4.2 above. If this result is only to be seen in obtaining further chemical compounds, then all known chemical compounds are equally suitable as the starting point for structural modification, and no inventive skill needs to be exercised in selecting, for instance, the compound of formula XIV of D3 for this purpose. Consequently, all structurally similar chemical compounds, irrespective of their number, that a skilled person would expect, in the light of the cited prior art, to be capable of being synthesised, are equally suitable candidates for solving such a hypothetical 'technical problem' to the skilled person, and would therefore all be equally 'suggested' to the skilled person. It follows from these considerations that a mere arbitrary choice from this host of possible solutions of such a 'technical problem' cannot involve an inventive step ... In other words, the Board holds that, in view of the underlying general legal principle set out in point 2.4.2 above, the selection of such compounds, in order to be patentable, must not be arbitrary but must be justified by a hitherto unknown technical effect which is caused by those structural features which distinguish the claimed compounds from the numerous other compounds. …

2.5.4 It follows directly from these considerations that a technical effect which justifies the selection of the claimed compounds must be one which can be fairly assumed to be produced by substantially all the selected compounds. …"

181. In *Abbott Laboratories Ltd v Evysio Medical Devices ULC* [2008] EWHC 800 (Ch), [2008] RPC 23, a case concerning coronary stents, Kitchin J (as he then was) said at [181]:

"… there is no invention in stipulating a feature which is arbitrary and serves no useful purpose. It has long been established that a patent cannot be used to prevent a person from doing what is merely an obvious extension of what has been done or was known in the art before the priority date. The public are entitled to make obvious products using obvious and and ordinary techniques. The selection of a number of these products by reference to an arbitrary parameter which has no technical significance does not involve an inventive step and does not create a patentable invention. It involves no technical ingenuity and solves no technical problem."

182. In *Conor Medsystems Ltd v Angiotech Pharmaceuticals Inc* [2008] UKHL 49, [2008] RPC 28, another case about coronary stents, Lord Hoffmann said:

"31. There is a line of authority in the EPO in which claims to broad classes of chemical compounds alleged to have some common technical effect have been rejected under Art. 56 (obviousness) when there is nothing to show that they would all have that technical effect. The leading case is *AGREVO/Triazole herbicides*, Case No T 0939/92, 12 September 1995, which was a product claim for a class of chemical compounds alleged to be useful as herbicides. But there was nothing in the description to justify the assertion that all the compounds in the class would have herbicidal properties. The Board of Appeal decided that the claims were not insufficient (the skilled man would have been able to make all the compounds claimed) but failed for lack of an inventive step because there was nothing inventive in simply making the compounds. The invention, if any, would lie in the discovery that they were herbicides. The Board of Appeal said (at paragraph 2.5.4) [see above]…

32. At paragraph 2.6.2 the Board acknowledged that a patentee does not have to have tested every compound to see whether it has the claimed effect: 'reasonable predictions of relations between chemical structure and biological activity are in principle possible, but that there is a limit beyond which no such prediction can be validly made.'

33. The case of *Johns Hopkins University School of Medicine Case/Growth Differentiation factor-9* No T 1329/04, 28 June 200 , deals with the question of whether the use which may be made of the claimed product (ie that which may constitute the inventive step) must be stated in the specification or can be proved by later evidence. The claim was to a DNA sequence encoding a protein 'having GDF-9 activity'. Again, as in *AGREVO*, there was nothing inventive in simply making the DNA sequence. The inventive step, if any, would lie in a disclosure that it coded for a useful protein. But the specification disclosed no more than speculation about how GDF-9 activity might be useful. The examining division rejected the application on the ground that such speculation did not go beyond what was obvious and refused to take into account subsequently published material showing specific properties of GDF-9.

34. The Board of Appeal pointed out (at para. 10) that in the specification various effects were 'tentatively and presumptively' attributed to GDF-9. It went on:

> '[T]he issue here is … how much weight can be given to speculations in the application in the framework of assessing inventive step, which assessment requires that facts be established before starting the relevant reasoning. In the board's judgment, enumerating any and all putative functions of a given compound is not the same as providing technical evidence as regard a specific one … [T]here is not enough evidence in the application to make at least plausible that a solution was found to the problem which was purportedly solved.'

35. The Board then went on to consider whether this deficiency could be remedied by evidence coming into existence after the application:

> '12. The appellant filed post-published evidence … establishing that GDF-9 was indeed a growth differentiation factor. This cannot be regarded as supportive of an evidence which would have been given in the application as filed since there was not any. The said post-published documents are indeed the first disclosures going beyond speculation. For this reason, the post-published evidence may not be considered at all. Indeed, to do otherwise would imply that the recognition of a claimed subject-matter as a solution to a particular problem could vary as time went by. Here, for example, had the issue been examined before the publication date of the earliest relevant post-published document, GDF-9 would not have been seen as a plausible solution to the problem … and inventive step would have had to be denied whereas, when examined thereafter, GDF-9 would have to be acknowledged as one such member. This approach would be in contradiction with the principle that inventive step, as all other criteria for patentability, must be ascertained as from the effective date of the patent. The definition of an invention as being a contribution to the art, i.e. as solving a technical problem and not merely putting forward one, requires that it is at least made plausible by the disclosure in the application that its teaching solves indeed the problem it purports to solve. Therefore, even if supplementary post-published evidence may in the proper circumstances also be taken into consideration, it may not serve as the sole basis to establish that the

application solves indeed the problem it purports to solve.'

36. These cases are in my opinion far from the facts of this case. The specification did claim that a taxol coated stent would prevent restenosis and Conor did not suggest that this claim was not plausible. That would have been inconsistent with the evidence of its experts that taxol was just the thing to try. It is therefore not surprising that implausibility was neither pleaded nor argued. The same was true of the proceedings in the Netherlands (see para.4.17 of the judgment).

37. The Court of Appeal upheld the judgment of Pumfrey J. on the ground that the patent contained no 'disclosure' saying that taxol was specially suitable for preventing restenosis. Again, I agree that the description, though offering a theory (its anti-angiogenic properties) as to why taxol would prevent restenosis, did not offer any evidence that this would turn out to be true. If it had not turned out to be true, the patent would have been insufficient. But there is in my opinion no reason as a matter of principle why, if a specification passes the threshold test of disclosing enough to make the invention plausible, the question of obviousness should be subject to a different test according to the amount of evidence which the patentee presents to justify a conclusion that his patent will work."

183. In *Dr Reddy's Laboratories (UK) Ltd v Eli Lilly & Co Ltd* [2009] EWCA Civ 1362, [2010] RPC 9, a case concerning the pharmaceutical olanzapine, Jacob LJ said:

"50. … The EPO jurisprudence is founded firmly around a fundamental question: has the patentee made a novel non-obvious technical advance and provided sufficient justification for it to be credible? That is the basis of all the reasoning – see e.g. [2.4.2] of *AgrEvo*. A 'selection' (by which I mean the later claimed compound or sub-class) which makes a real technical advance in the art is patentable.

51. More specifically Mr Carr contended that a sub-class or individual member of a prior art published class was taken to be obvious if it was a random selection from the earlier published class. I have no difficulty with that. Such a 'selection' provides no technical contribution. Mankind can learn nothing from it. Nor indeed does Lilly dispute that proposition. It said in its skeleton argument: 'Lilly does not dispute that in relation to obviousness a selection from the prior art cannot be merely arbitrary.'

52. Of course one has to consider here what is meant by an 'arbitrary selection'. The answer is to be found in the guiding principle – is there a real technical advance?"

184. In the same case Lord Neuberger of Abbotsbury MR said at [104]:

> "... the Board's approach in cases such as these is consistent and clear, and it is based on its general approach to patent validity on novelty and obviousness. There is nothing in the 1977 Act (any more than there was in the 1949 Act, it is fair to say) which recognises, or even implies, a special approach to, or even the existence of, selection patents as a special category of patent, which require a different approach when determining validity from other patents… "

185. What these cases show is that the principles to be applied in determining whether a claimed invention is obvious are the same regardless of the field of the invention, but that the application of those principles can vary according to the circumstances of the case, including the field of the invention. An arbitrary selection from the prior art is not inventive, regardless of the field. Nevertheless this is a problem which is more likely to arise with claims to classes of chemical compounds for the reasons explained by the Board of Appeal in *Agrevo*. Where it is suggested that a claimed invention is obvious as being an arbitrary selection, the key question is whether the specification "passes the threshold test of disclosing enough to make the invention plausible" as Lord Hoffmann put it in *Conor v Angiotech*, that is to say, to make it plausible that the selection has the technical significance claimed for it.

186. In my judgment the evidence in the present case demonstrates convincingly that claim 6 of the Patent is an arbitrary selection. Not only does the specification not make it plausible that the selection of tools coated with α-alumina with a TC(012) greater than 1.3, or 1.5, has any technical significance, but also subsequent evidence indicates the opposite.

187. *The specification*. The specification does not render it plausible that the selection has any technical significance for the following reasons. First, the flaking tests reported in the examples all compare tools in accordance with the invention with κ-alumina and mixed κ/α-alumina tools. As Dr James accepted, these prove nothing about the value of texture in the (012) direction. There is no comparison of tools coated with α-alumina with a TC(012) greater than 1.3, or 1.5, with tools coated with α-alumina with a random orientation or a different texture.

188. Secondly, insert A in Example 1 is reported to have a TC(012) of 2.1. At best, therefore, the Patent suggests that a TC(012) of 2.1 is beneficial. As noted above, there is nothing in the specification to explain or justify the choice of 1.3 or 1.5 as the limit in the claims. The skilled reader would appreciate that 2.1 was significantly higher than 1.3 or even 1.5.

189. Thirdly, the claim does not exclude cutting tools which have a greater degree of orientation in another direction. A simple example of this is given in paragraph 11 above. Even assuming that tools with texture just in the (012) direction would deliver the claimed advantages of improved wear and toughness, it is implausible that tools with a greater degree of orientation in another direction would do so.

190. Fourthly, the skilled reader reading the specification with his common general knowledge would not have regarded a TC value of 1.3, or even 1.5, in any direction as

significantly different from random orientation anyway. Professor Bull's evidence was that at that time he did not consider a coating to be textured unless the TC was larger than about 3. Furthermore, his experience with TC values of α-alumina before the priority date was that the tools he tested were typically around 1±0.5, including in the (012) plane. He considered these to be close to random and not in the least out of the ordinary. Similarly, Kim refers to coatings with TC values of 1.41 and 1.43 as having "random orientation".

191. *Subsequent evidence*. Several strands of evidence indicate that the selection of tools coated with α-alumina with a TC(012) greater than 1.3, or 1.5, has no technical significance. First, the expert evidence. Professor Bull's evidence was clear:

> "The texture claimed in the Patent is a red herring. I believe that grain size control and adhesion control are still the most important values in tool coating production."

For his part, Dr James agreed that grain size and adhesion were important. He considered that a strongly textured coating, with a TC(012) value above 5, was advantageous; but neither he nor Professor Thomas was able to say that a TC(012) of slightly above 1.3, or even slightly above 1.5, provided any technical benefit.

192. Secondly, papers published since 1992 continue to treat TC values of the order of 1.3 or 1.5 as consistent with a random orientation. Thus the 2005 paper by Ruppi describes alumina coatings with a TC value of 1.78 as having "weak texture" and coatings with TC values of 2.57 to 5.48 as having "pronounced texture". Similarly, a presentation given by Ruppi in 2008 refers to a coating with a TC value of 1.45 as "random".

193. Thirdly, Dr Brandt gave evidence in his US deposition that Sandvik does not undertake any routine testing on its own products to check that they have a TC(012) of greater than 1.3.

194. Fourthly, Dr Brandt also gave evidence that, when testing Kennametal's tools for infringement, Sandvik found that, even in the same grade of tool, some tools had the required TC(012) value and some did not.

195. Fifthly, Sandvik has obtained a series of patents in very similar terms to the Patent claiming benefits of improved tool life and machining in α-alumina coatings with TC values over 1.3 or 1.5 in the (012), (104), (110), (024) and (300) orientations.

196. *Conclusion*. I conclude that claim 6 is obvious for the reasons advanced by counsel for Kennametal.

Obviousness of claim 7

197. The inventive concept of claim 7 is a method for producing a body with an α-alumina layer in accordance with claim 1 by a process in which (i) the water vapour in the hydrogen is kept below 20 ppm, (ii) the gases are introduced in the order CO_2, CO and $AlCl_3$ and (iii) the temperature is about $1000^{o}C$. Given that it was common general knowledge that the water vapour content should be carefully controlled and

that the temperature was conventional, the key feature of the process is the sequence of the gases.

198. Kennametal contend that claim 7 was obvious over common general knowledge. In support of this contention they rely on Professor Bull's opinion that it was obvious because (i) it was common general knowledge to use CO to control the amount of water produced by the water gas shift reaction, (ii) it was obvious to introduce the CO_2 and CO before the $AlCl_3$ and (iii) there was nothing inventive in introducing CO_2 first and CO second.

199. I am not persuaded by this reasoning, which involves a classic step-by-step hindsight analysis. More fundamentally, in my view it involves an intellectual sleight of hand. Although I have accepted that claim 6, and thus *a fortiori* claim 1, involves an arbitrary selection from the prior art, it does not mean that the requirement of claim 7 that the method produce a body with an α-alumina coating in accordance with claim 1 can be ignored. For the reasons I have given when considering insufficiency, I do not consider that it would have been obvious to the skilled person how to make a coating with a TC(012) greater than 1.3 otherwise than by chance. Still less would have it been obvious that the sequence of gases specified in claim 7 would produce such a coating.

200. I therefore conclude that claim 7 was not obvious.

Infringement

201. There are two issues on infringement. The first arises out of integer [3] of claim 1. Kennametal contend that the XRD experiments performed by Professor Thomas on behalf of Sandvik do not establish that the coating is single phase α-alumina, but demonstrate the presence of amorphous alumina. This issue partly depends on the question of construction considered above. It also depends on the expert evidence.

202. So far as the expert evidence is concerned, there was a stark conflict of evidence between Professor Bull and Professor Thomas. It is common ground that the XRD spectra display broadening on the low-angled side of a number of the peaks. Professor Bull and Professor Thomas were disagreed as to the explanation for this. Professor Bull's opinion was that it was attributable partly to strain broadening and partly to the presence of amorphous alumina, while Professor Thomas' opinion was that it was wholly attributable to strain broadening. Both experts gave detailed and persuasive reasons in support of their respective opinions. Despite the cross-examination of the experts, and the submissions of counsel, I have not been able to come to a conclusion as to who is right about this.

203. I note that the Düsseldorf Court did not think that amorphous alumina was present, but it did not have the benefit of the expert evidence which I have. Furthermore, it recorded that Kennametal had suggested that amorphous alumina was present for the first time at the oral hearing, which the court regarded as contradicting their written submission that the "shadow peaks" demonstrated the presence of an unidentified phase of alumina (see page 26 of the judgment).

204. Professor Bull and Professor Thomas were agreed that it would be possible to resolve this issue by TEM analysis, which Professor Bull estimated would take about a week and cost about £5,000. Neither side has carried out such analysis, however.

205. It follows that I am forced to resort to the burden of proof to determine this issue. Counsel for Kennametal submitted that the burden lay upon Sandvik to demonstrate the presence of "single phase α-structure", and that the XRD analysis it relied on did not discharge that burden. Counsel for Sandvik accepted that the starting point was that the burden lay upon Sandvik to demonstrate the presence of "single phase α-structure", but he submitted that the burden lay upon Kennametal to establish the presence of amorphous alumina since it was advancing a positive case to that effect. He also submitted that it would be procedurally unfair to place the burden of disproving the presence of amorphous alumina on Sandvik. In support of this, he pointed out that Sandvik had asked Kennametal by letters dated 9 August 2011, 15 August 2011, 30 September 2011 and 7 October 2001 whether Kennametal was advancing a positive case that the samples tested did not fall within claim 1, but Kennametal had not replied to this request. Thus the first time that Sandvik became aware that Kennametal were suggesting that amorphous alumina was present was when Professor Bull's first report was served on 1 November 2011. It is clear from Professor Bull's evidence, however, that he had advised Kennametal of his opinion well before this.

206. Counsel for Kennametal argued that Sandvik had been aware that Kennametal were saying that there was amorphous alumina present since Kennametal had served their written submissions in the German proceedings on 15 February 2011. It is evident from the judgment of the Düsseldorf Court that it did not understand that to be the case from those submissions, however, and therefore there is no reason why Sandvik should have. In any event, as counsel for Sandvik pointed out, there was no reason for Sandvik to assume that the same points would be argued in these proceedings in the absence of any indication to that effect. It is clear from the judgment of the Düsseldorf Court that there are differences in the positions of both parties in the respective proceedings.

207. Counsel for Kennametal also suggested that it was Sandvik's fault that the expert's reports had been exchanged so late, but counsel for Sandvik disputed this. I cannot resolve this issue.

208. In any event, the key point remains that Sandvik squarely asked Kennametal whether they were advancing a positive case as long ago as 9 August 2011, but Kennametal failed to reveal that they were going to contend that amorphous alumina was present. If Kennametal had revealed this, Sandvik could have carried out a TEM analysis in good time for trial. In these circumstances, I conclude that the burden lies on Kennametal to establish the presence of amorphous alumina both because they are advancing a positive case and because it would be procedurally unfair to place the burden of disproving the presence of amorphous alumina on Sandvik. Kennametal have failed to discharge that burden. I therefore find that the samples tested by Professor Thomas fall within the claim.

209. The second issue on infringement arises out of the fact that Sandvik has alleged infringement by quite a large number of different grades of insert made and sold by Kennametal. Kennametal's Production Description states that the allegedly infringing

grades were made by 13 different combinations of coat processes and post-coat processes identified in a Confidential Appendix. Rather than undertake experiments to prove infringement on samples from each of the 13 combinations, however, Sandvik only tested five grades made by process combinations 2 and 4. It did not test grades made by any of the other 11 process.

210. In his first report Dr James expressed the opinion that the differences between the two process combinations tested and the others was not material to the issue of infringement. In cross-examination, however, it became clear that he had assumed that every detail of the alumina deposition process was the same. Kennametal contend that there is no basis for that assumption, not least because Kennametal had made it clear earlier in the proceedings that the processes varied. Sandvik ripostes that there is nothing in the Product Description to suggest that the alumina deposition process differed between the various combinations.

211. In my judgment Sandvik has not proved that grades made by the process combinations other than 2 and 4 fall within the claim. In my view Sandvik was not justified in assuming that there was no material difference between those combinations and the other 11. First, on the face of the Appendix to the Product Description, there are differences in the layers of coatings (including the layer underneath the alumina layer) and in the thickness of the alumina layer. As explained above, the evidence shows that these factors are capable of affecting the texture coefficient of the alumina. Secondly, in circumstances where Kennametal had expressly stated that there were differences in the processes, Sandvik was not justified in relying on the omission of any detailed description of those differences from the Product Description. While it is correct that it is incumbent on a party producing a Product Description to give a level of detail sufficient to enable the issue on infringement to be determined, in the present case it was clear to both sides that Sandvik would need to do, and would do, experiments to establish infringement. In those circumstances, Kennametal were entitled to proceed on the basis that Sandvik would do whatever experiments it deemed necessary or, if appropriate to avoid unnecessary experimentation, press for further particularisation of the Process Description.

212. Counsel for Sandvik relied on the fact that the Düsseldorf Court had concluded at page 45 of the judgment that the samples tested for those proceedings were representative of all those alleged to infringe. That was clearly a decision reached in accordance with German procedural considerations, however. The procedural situation in these proceedings is different, not least because there does not appear to have been any equivalent of the Product Description in the German proceedings.

Conclusions

213. For the reasons given above, I conclude that:

i) the Patent is invalid on the ground of insufficiency;

ii) claims 1-6 of the Patent are also invalid on the ground of obviousness, but not claim 7;

iii) Sandvik has established that, if the Patent were valid, the Kennametal grades of insert made by process combinations 2 and 4 would infringe the product claims, but not the Kennametal grades of insert made by the other process combinations.