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GB 1503005 A GB 1334584 A EP 0239485 A2
EP 0149425 A1 WO 83/02555 A1 US 4892549 A
US 4031570 A

(58) Field of Search
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INT CL[5] A61F 2/30 2/32 2/34 2/36
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(54) Orthopaedic implant

(57) An orthopaedic implant, eg an acetabular cup, has a surface 11 adapted to make contact with the bone which surface is partly or fully textured. The finish comprises a series of inclined ridges or troughs arranged in a regular formation to provide a roughened surface. The ridges or troughs can be arranged in a diamond or square formation. The roughened surface encourages bone in-growth in an even manner. A method and a tool for applying the finish to the surface of the implant are also disclosed.

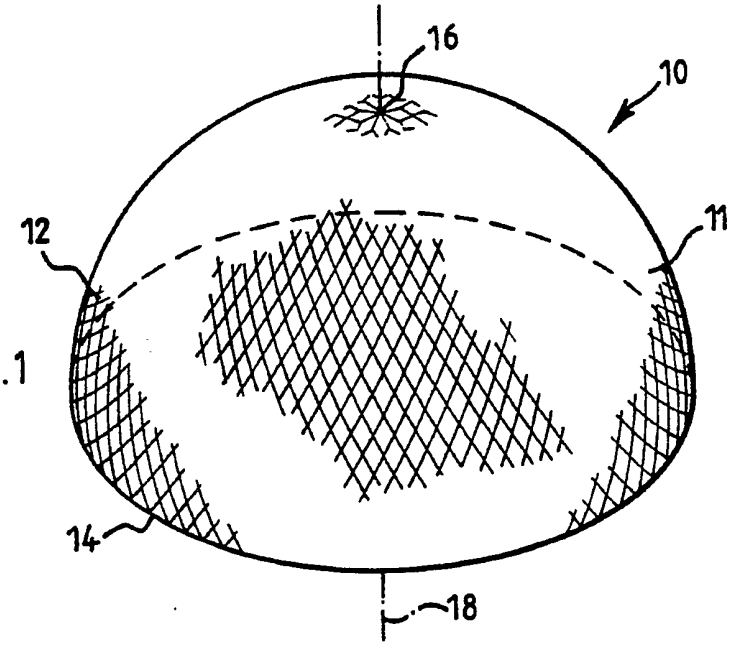

FIG.1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

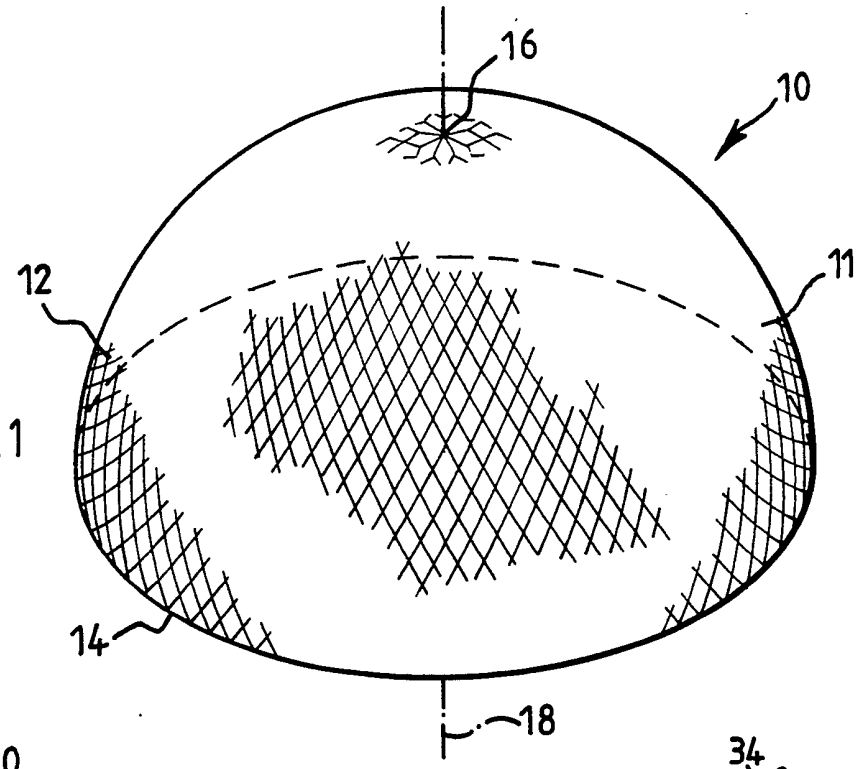


FIG.1

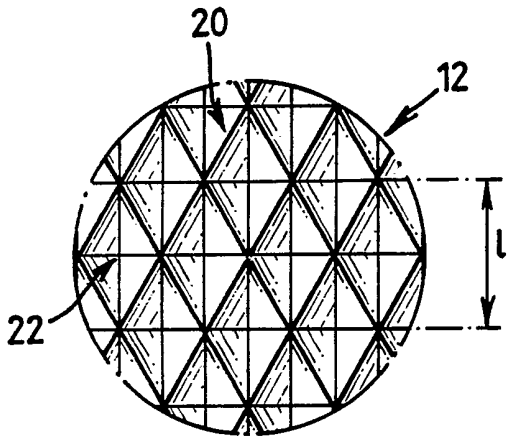


FIG.2a

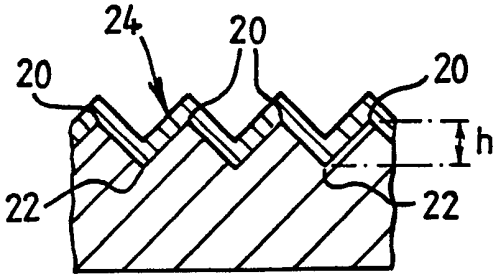


FIG.2b

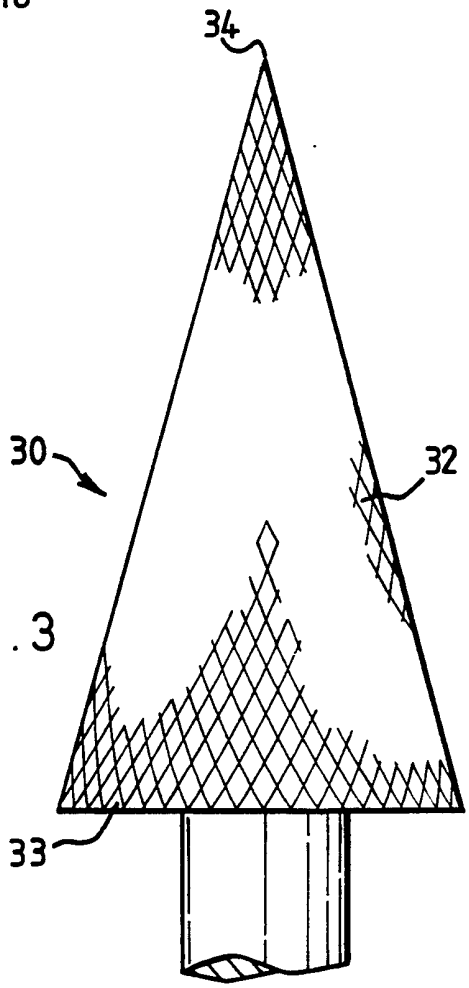


FIG.3

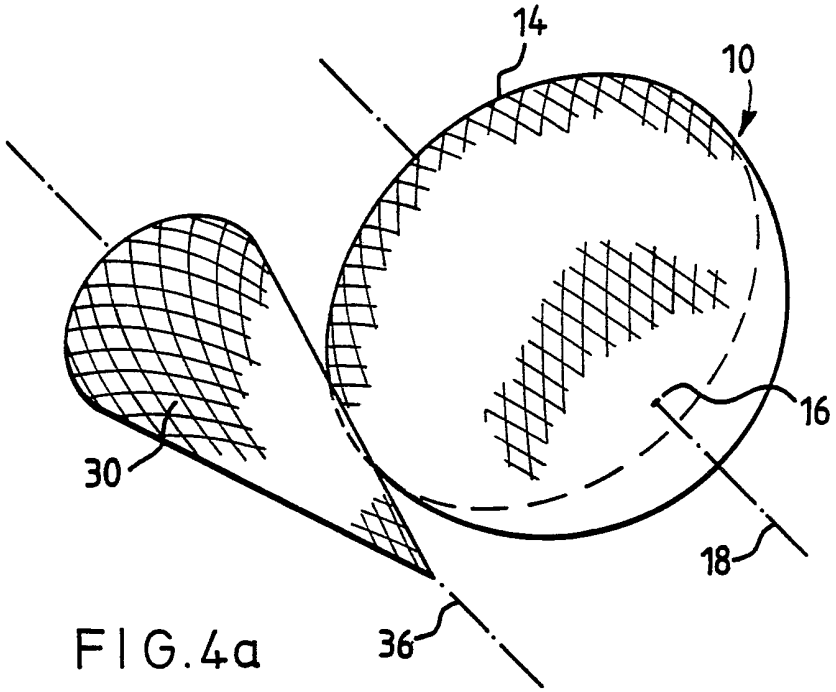


FIG.4a

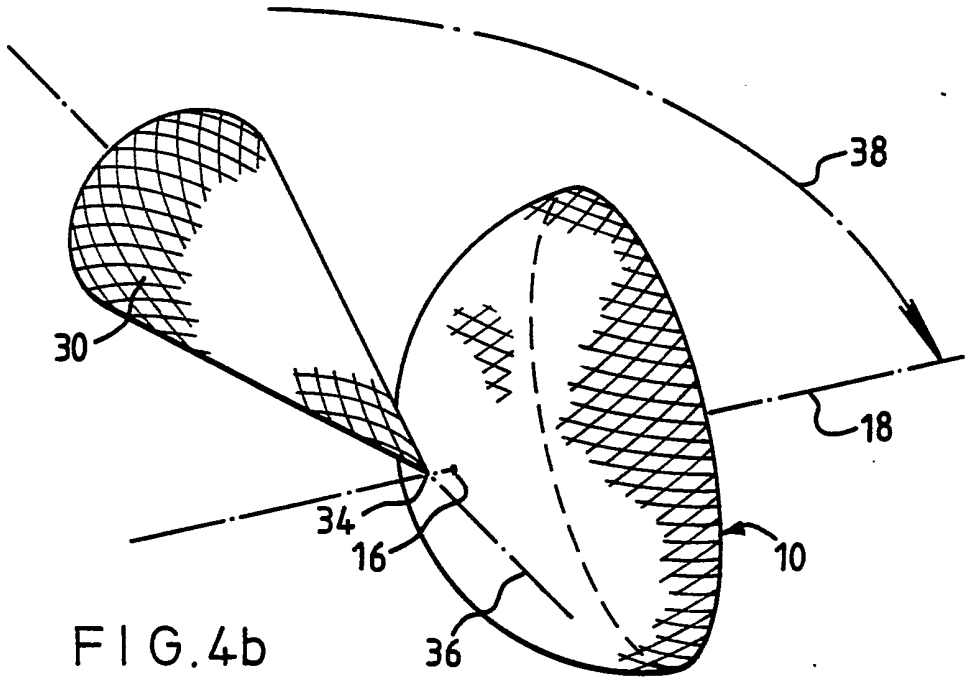


FIG.4b

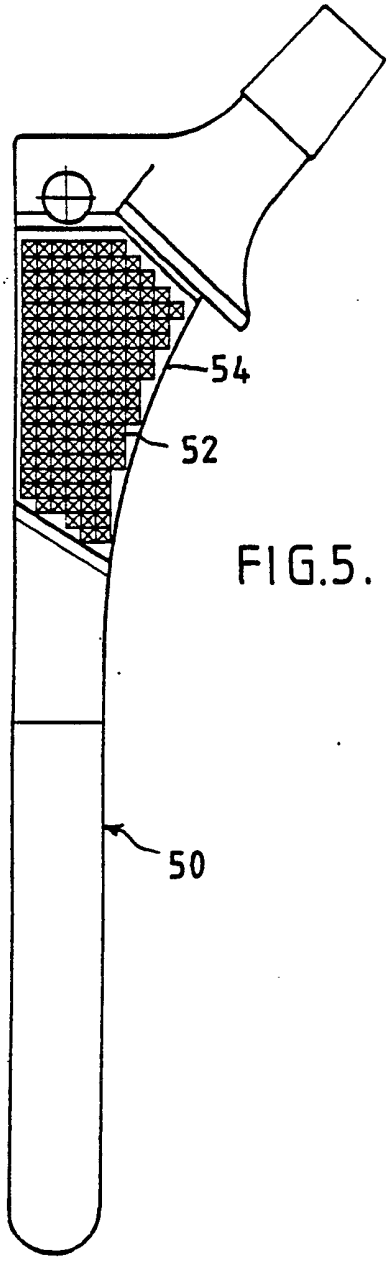


FIG.5.

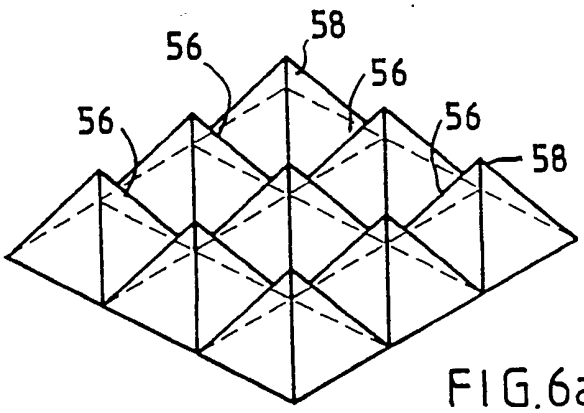


FIG.6a.

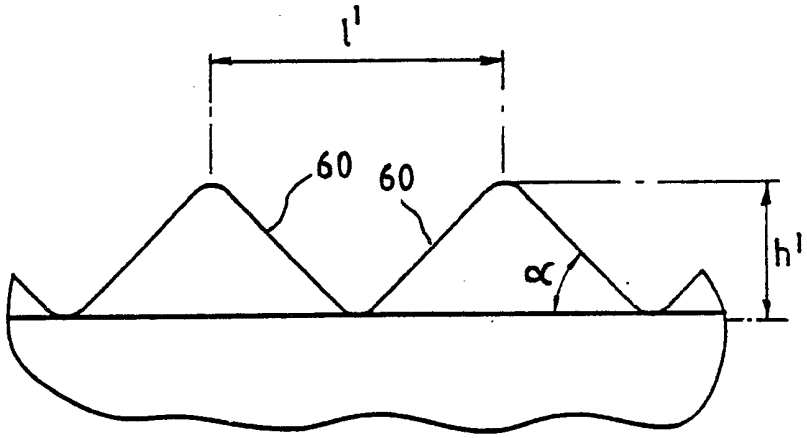
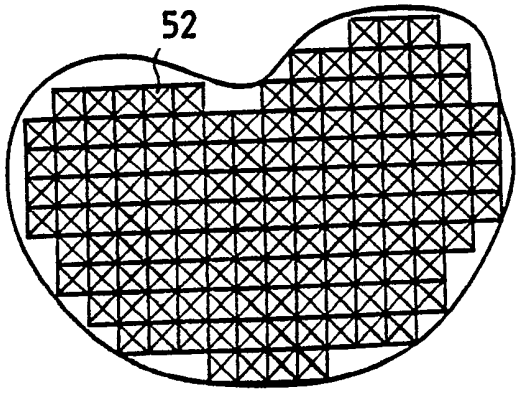


FIG.6b.

FIG.7.



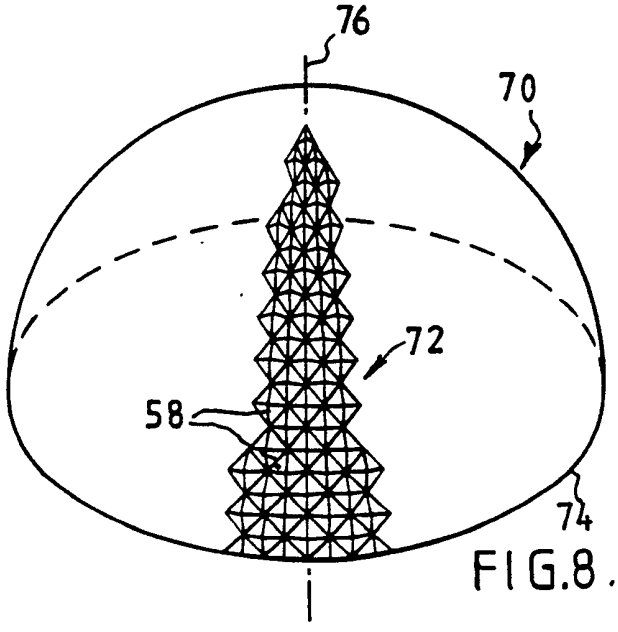


FIG.8.

AN ORTHOPAEDIC IMPLANT AND A METHOD AND TOOL FOR MANUFACTURING THE SAME

The invention relates to an orthopaedic implant adapted for making direct contact with adjacent bone, a method for manufacturing the implant and a tool for use in the method.

Implants having a roughened surface on the area intended to make direct contact with adjacent bone are known for example from UK patent No. 2181354. However, the surface finish applied to the implant illustrated in this patent is difficult to apply to arcuate surfaces, and in particular hemispherical surfaces. If the surface finish disclosed in this patent were to be applied to a hemispherical surface, the texture would be lost at the apex of the hemisphere. This and other surface finishes also have the disadvantage that the bone in-growth achieved can be somewhat irregular and therefore points of high stress occur in the interface between the implant and the adjacent bone.

It is an object of the present invention to provide an implant which overcomes the aforementioned disadvantages. It is a further object of the invention to provide a method for manufacturing such an implant and also to provide a tool for use in such a method.

The invention provides an orthopaedic implant adapted for making direct contact with adjacent bone, at least part of the surface of the implant adapted to make contact with the bone having a textured finish, wherein the finish comprises a series of inclined ridges or troughs arranged in a regular formation to provide a roughened surface.

Preferably, the ridges or troughs are arranged in a diamond or square formation and, more preferably, the finish comprises a series of troughs or ridges arranged such that the surface is configured as a series of adjacent pyramid-shaped protrusions or indentations. The pyramid-shaped troughs or protrusions can be square-based or diamond-based.

Further advantageous features of the invention are set out in sub-claims 7 to 17.

The regular formation of ridges or troughs arranged on the surface of the implant encourages bone in-growth in an even manner. This is particularly effective when the ridges or troughs are arranged in a square or diamond formation. The even bone in-growth reduces the risk of stress points occurring in the implant/bone interface and therefore reduces the risk of the implant slipping with relation to the bone.

The invention also provides a method of applying a surface finish to the hemispherical surface of an orthopaedic implant comprising pressing a conical or

frusto-conical tool carrying the subject pattern of the surface finish tangentially against the hemispherical surface and causing both the tool and the implant to rotate about their respective axes whilst maintaining the pressing contact to apply the surface finish to the implant, the axis of the tool subsequently being rotated relative to the axis of the implant to increase the surface area to which the finish is applied, wherein the finish applied to the implant comprises a series of inclined ridges or troughs arranged in a regular formation.

Preferably the surface finish is applied to substantially the entire hemispherical outer surface of the implant.

Preferably, the tool is drivably rotated, the pressing contact between the tool and the implant causing the implant to rotate with the tool.

More preferably, the point of contact between the implant and the tool is initially located substantially at the base of the hemispherical outer surface of the implant and subsequently moves towards the pole of the hemispherical outer surface.

Preferably, the surface finish applied to the implant is substantially as described above. The nature of the method according to the invention is such that the surface finish can be applied to the entire outer surface of a hemispherical implant without detracting

from the regularity of the surface finish. The surface finish can therefore be applied reliably to the pole or apex of the hemispherical surface and results in an implant being produced which is less likely to have stress points located on the interface between the hemispherical surface and adjacent bone.

The invention further provides a tool for use in a method as described above, the tool having a conical or frusto-conical surface carrying the subject pattern of the surface finish comprising a series of inclined ridges or troughs. Preferably, the ridges or troughs are arranged in a diamond or square formation, when applied to the surface of the implant and, more preferably, the diamonds or squares all point towards the apex of the cone. Advantageously, the longer dimension of each diamond measures between 0.2mm and 5mm and preferably the height of the ridges or troughs is between 0.2mm and 5mm, more preferably 1mm.

Embodiments of the orthopaedic implant, the method and the tool according to the present invention will now be described with reference to the accompany drawings wherein:

Figure 1 is a perspective view of an acetabular cup forming part of an implant according to a first embodiment of the present invention;

Figure 2a is an enlarged plan view of part of the surface of the cup shown in Figure 1;

Figure 2b is an enlarged section through the portion of the cup shown in Figure 2a;

Figure 3 is a side view of a tool according to the present invention;

Figure 4a is a schematic diagram showing the initial stages of a method according to the invention;

Figure 4b is a schematic diagram showing the later stages of a method according to the present invention;

Figure 5 is a plan view of a femoral hip implant carrying a surface finish according to a second embodiment of the invention;

Figure 6a is a perspective enlarged view of the surface finish shown in Figure 5;

Figure 6b is an enlarged section through the surface shown in Figure 6a;

Figure 7 illustrates the use of the finish shown in Figures 5 and 6 on irregular surfaces; and

Figure 8 is a perspective view showing an acetabular cup carrying the surface finish illustrated in Figures 5 and 6.

Figure 1 shows an acetabular cup 10 having an outer surface 11 carrying a textured surface finish 12. The surface finish 12 extends over the majority of the outer surface 11 from an area in the region of the base 14 of the hemisphere to an area in the region of the apex or pole 16 of the hemisphere. The hemispherical cup has an axis of rotation 18 which extends through the pole 16.

Figures 2a and 2b show enlarged views, in plan and section respectively, of the surface finish 12. The surface finish 12 is made up of a series of ridges 20 which are arranged in a diamond formation and which are each inclined so that a series of depressions 22 are formed between the ridges 20. Each depression 22 is surrounded by a diamond shape of ridges 20 to produce a diamond-based, pyramid-shaped indentation. The height h of the ridges 20 (ie. the vertical height between the bottom of the depressions 22 and the top of the ridges 20) is between 0.2mm and 5mm, preferably substantially 1mm. Also, the longer dimension l of each diamond (ie. the distance between the upper and lower apex of each diamond as shown in Figure 2a) is between 0.2mm and 5mm, preferably substantially 3mm.

As can be seen from Figure 2b, the surface finish 12 is coated with a coating 24 such as hydroxyappatite which encourages bone in-growth into the depressions 22 between the ridges 20. This will assist in producing a firm and even interface between the implant and the adjacent bone. It is to be understood that any other suitable coating which would achieve the same or similar effect could be used.

As will also be apparent from Figures 1 and 2a, the long axes of the diamonds all point towards the axis 18 of the cup 10. If the long axes of the diamonds were projected, they would eventually intersect with the

axis 18. As the diamonds approach the pole 16 of the cup 10, the diamonds all converge towards the pole 16. This arrangement produces a surprisingly even interface between the implant and the adjacent bone and reduces the likelihood of stress points in the interface.

Figure 3 shows a tool 30 suitable for applying the surface finish 12 onto the cup 10. The tool 30 is conical in shape and carries the subject pattern 32 of the surface finish consisting of a series of inclined troughs arranged in a regular formation. The subject pattern 32 of the surface finish extends from an area adjacent the base 33 of the tool 30 to the apex 34. The subject pattern 32 of the surface finish is arranged such that the troughs form a regular diamond pattern and each of the upper corners of the diamonds point towards the apex 34 of the cone.

The tool illustrated in Figure 3 is used to apply a surface finish to an implant 10 in the following manner. The tool 30 and implant 10 are arranged as illustrated in Figure 4a. The axes 18 and 36 of the implant and tool respectively are located with respect to one another so that the surface of the tool 30 tangentially contacts the implant 10 close to the base 14 of the hemisphere. The tool 30 is pressed against the implant 10 at a normal knurling pressure and rotated about its axis 36 by means of a motor or other driving means (not shown). The implant 10 is arranged so as to

be freely rotatable about its axis 18 and thus the contact pressure of the rotating tool 30 causes the implant 10 to rotate with the tool 30. In this way, a narrow band of the implant 10 adjacent the base 14 thereof has the surface finish 12 impressed into its surface 11.

When the narrow band of the implant 10 has been sufficiently well textured, the axis 18 of the implant is rotated relative to the axis 36 of the tool so that the tool 30 now contacts a second band of the hemispherical surface 11 of the implant 10 adjacent the band which has just been textured. It is not necessary to slow or stop the rotation of the tool and implant in order to achieve this; the surface 11 of the implant 10 is merely rolled along the surface of the rotating tool 30. The axis 18 of the implant 10 is slowly rotated in the direction of arrow 38 until the apex or pole 16 of the hemispherical implant 10 is in contact with the apex 34 of the tool. If desired, the implant need not be rotated quite this far; if the surface finish is not required to continue as far as the pole 16 of the hemispherical cup 10, then the rotation can be terminated at an earlier stage. Equally, the initial contact between the implant 10 and the tool 30 could be at the pole 16 and apex 34 and the relative rotation of the axes could be reversed.

By using the method according to the invention, the

textured surface 12 can be applied to the hemispherical surface of the cup 10 from the base 14 to the pole 16 without any serious distortion of the surface finish taking place. Naturally, other surface finishes can also be applied to hemispherical surfaces in the same manner.

A second embodiment of an implant according to the invention is illustrated in Figures 5 to 8. Figure 5 shows a femoral hip implant 50 carrying a textured surface finish 52 (not shown to scale) on the stem 54 thereof. The surface finish 52 is shown on an enlarged scale in Figure 6a and comprises a series of troughs 56 arranged in a regular formation so that the surface 52 comprises a series of square-based pyramid-shaped protrusions 58 which are shown on a further enlarged scale in Figure 6b. The height h' of the protrusions 58 is substantially 1mm and the distance l' between two adjacent peaks is substantially 2mm. The angle of the inclined surface 60 to the horizontal is substantially 45°. As described above, the protrusions 58 can be coated with a coating such as hydroxyappatite to encourage bone in-growth into the troughs 56 between the protrusions 58. The pyramid-shaped protrusions 58 can be cast into the surface of the implant.

This type of surface finish 52 is as effective as that illustrated in Figures 1 and 2 and has similar advantages. It can be easily adapted to any shape of

surface to which the finish is to be applied. Examples of planar-surfaces are shown in Figures 5 and 7. Furthermore, the finish can be applied to arcuate or other non-planar surfaces as illustrated in Figure 8. In Figure 8, a hermispherical acetabular cup 70 is shown having a surface finish 72. The finish 72 comprises square-based pyramid-shaped protrusions 58 as illustrated in Figure 6a around the base 74 of the cup 70. The shape of the bases of the protrusions 58 gradually changes to a diamond shape as the protrusions 58 approach the apex 76 of the cup 70 and become elongate in the area adjacent the apex 76. This formation of protrusions 58 can be applied to the entire surface area of a hemispherical surface of an implant without loss of regularity in the area of the apex. The bone in contact with the implant is encouraged to graft with the implant by growing into the troughs between the protrusions.

The surface finish 72 described above in relation to Figure 8 is applied to the hemispherical surface in the same way as the surface finish 12 shown in Figures 1 and 2 is applied to the cup 10. A conical tool carrying the subject pattern of the desired surface finish is pressed against the surface at knurling pressure. The axes of rotation of the tool and the implant are arranged so that the base of the implant is in contact with the tool. After sufficient operation of the tool to ensure

that the surface finish has been adequately applied to the narrow band of the implant adjacent the base, the axis of the tool is rotated relative to that of the implant to bring an adjacent band of the implant into contact with the tool. Progressive rotation of the axis of the tool relative to the implant results in the entire surface of the implant, or the desired portion thereof, being textured.

It is envisaged that either of the surface finishes applied to an implant could, in fact, be reversed with respect to those described above: the ridges arranged in the diamond formation shown in Figures 1 and 2 could in fact be reversed as troughs with raised protrusions occuring between the troughs. The bone in-growth would then be into the troughs between the protrusions and the same effect would be achieved. Similarly, the finish illustrated in Figures 5 to 8 could be reversed as ridges with depressions therebetween such that bone-in-growth is into the depressions. Furthermore, the ratio of the longer axis to the shorter axis of each diamond need not be as illustrated in Figure 2 but could be increased to produce longer, narrower diamonds or decreased to produce shorter, wider diamonds. Also, the square-based pyramids show in in Figures 5 to 8 could be replaced by diamond-based pyramids. Such variations would fall within the scope of the invention.

The implant can be made from a variety of suitable

materials, examples of which are Polysulfone, Peek and composite materials such as carbon fibre/epoxy. Equally, a textured surface finish such as that described above can be applied to metal implants if desired, for example by casting. It is also envisaged that the method can be used to apply a textured surface finish to a flat surface, if necessary by using a tool having a convex outer surface.

CLAIMS

1. An orthopaedic implant adapted for making direct contact with adjacent bone, at least part of the surface of the implant adapted to make contact with the bone having a textured finish, wherein the finish comprises a series of inclined ridges or troughs arranged in a regular formation to provide a roughened surface.

2. An implant as claimed in claim 1, wherein the ridges or troughs are arranged in a diamond or square formation.

3. An implant as claimed in claim 1 or 2, wherein the finish comprises a series of troughs arranged such that the surface is configured as a series of adjacent pyramid-shaped protrusions.

4. An implant as claimed in claim 1 or 2, wherein the finish comprises a series of ridges arranged such that the surface is configured as a series of pyramid-shaped indentations.

5. An implant as claimed in claim 3 or 4, wherein at least some of the pyramid-shaped protrusions or indentations are square-based.

6. An implant as claimed in any one of claims 3 to 5, wherein at least some of the pyramid-shaped protrusions or indentations are diamond-based.

7. An implant as claimed in any one of the preceding claims, wherein the surface to which the finish is applied is planar.

8. An implant as claimed in any one of claims 1 to 6, wherein the surface to which the finish is applied is hemispherical or part-hemispherical.

9. An implant as claimed in claims 5, 6 and 8, wherein the surface to which the finish is applied is hemispherical, the applied finish consisting of a regular formation of square-based pyramid-shaped protrusions at or adjacent the base of the hemisphere and of a regular formation of diamond-based pyramid-shaped protrusions at or adjacent the apex of the hemisphere.

10. An implant as claimed in claim 9, wherein the longer axis of each diamond, when projected, intersects the axis of the hemispherical surface.

11. An implant as claimed in any one of the preceding

claims, wherein the height of the ridges or troughs is between 0.2mm and 5mm.

12. An implant as claimed in claim 11, wherein the height of the ridges or troughs is substantially 1mm.

13. An implant as claimed in claim 6 and any of the remaining preceding claims, wherein each diamond has a longer dimension of between 0.2mm and 5mm.

14. An implant as claimed in claim 13, wherein the longer dimension of each diamond is substantially 2mm.

15. An implant as claimed in any one of the preceding claims, wherein the surface is coated with a coating which encourages bone in-growth either between the ridges or into the troughs.

16. An implant as claimed in claim 15, wherein the coating comprises hydroxyappatite.

17. An implant as claimed in any one of the preceding claims, wherein the implant is made from any one of Polysulfone, Peek and a carbon fibre/epoxy composite material.

18. An orthopaedic implant substantially as herein described with reference to the accompanying drawings.

19. A method of applying a surface finish to the hemispherical surface of an orthopaedic implant comprising pressing a conical or frusto-conical tool carrying the subject pattern of the surface finish tangentially against the hemispherical surface and causing both the tool and the implant to rotate about their respective axes whilst maintaining the pressing contact to apply the surface finish to the implant, the axis of the tool subsequently being rotated relative to the axis of the implant to increase the surface area to which the finish is applied, wherein the finish applied to the implant comprises a series of inclined ridges or troughs arranged in a regular formation.

20. A method as claimed in claim 11, wherein the surface finish is applied to substantially the entire hemispherical surface of the implant.

21. A method as claimed in claim 19 or 20, wherein the tool is drivably rotated, the pressing contact between the tool and the implant causing the implant to rotate with the tool.

22. A method as claimed in any one of claims 19 to 21, wherein the point of contact between the implant and the tool is initially located substantially at the base of the hemispherical outer surface of the implant and subsequently moves towards the pole of the hemispherical outer surface.

23. A method as claimed in any one of claims 19 to 22, wherein the ridges or troughs of the surface finish applied to the implant are arranged in a diamond or square formation.

24. A method as claimed in claim 23, wherein the longer axis of each diamond, when projected, intersects the axis of the hemispherical surface.

25. A method as claimed in any one of claims 19 to 24, wherein the height of the ridges or troughs applied to the surface is between 0.2mm and 5mm.

26 A method as claimed in claim 25, wherein the height of the ridges or troughs applied to the surface is substantially 1mm.

27. A method of applying a surface finish to an orthopaedic implant substantially as herein described with reference to the accompanying drawings.

28. An orthopaedic implant made according to a method as claimed in any one of claims 19 to 27.

29. A tool for use in a method according to any one of claims 19 to 27, the tool having a conical or frusto-conical surface carrying the subject pattern of a surface finish comprising a series of inclined ridges or troughs.

30. A tool as claimed in claim 29, wherein the ridges or troughs are arranged in a diamond or square formation when applied to the surface of the implant.

31. A tool as claimed in claim 30, wherein the diamonds or squares all point towards the apex of the cone.

32. A tool as claimed in claim 30 or 31, wherein the longer dimension of each diamond measures between 0.2mm and 5mm.

33. A tool as claimed in any one of claims 29 to 32, wherein the height of the ridges or troughs is between 0.2mm and 5mm.

34. A tool as claimed in claim 33, wherein the height of the ridges or troughs is substantially 1mm.

35. A tool substantially as herein described with reference to the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

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Relevant Technical fields

(i) UK Cl (Edition L) A5R (RAB, RAJ)

(ii) Int Cl (Edition 5) A61F 2/30; 2/32; 2/34; 2/36

Search Examiner

N A FRANKLIN

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES: WPI

Date of Search

3 JUNE 1993

Documents considered relevant following a search in respect of claims 1 TO 18, 19 TO 28

Category (see over)	Identity of document and relevant passages		Relevant to claim(s)
X	GB 1503005	(CERAVER) Note Figures 1 & 2	1 at least
X	GB 1334584	(CERAVER) Note page 1, lines 59-65 and Figure 1	1 at least
X	EP 0239485 A2	(PERRIN) Note Figures 2 & 10	1 at least
X	EP 0149425 A1	(MATHYS) Note Figure 1	1 at least
X	WO 83/02555 A1	(US MEDICAL CORPORATION) Note fins 28 in Figure 5	1 at least
X	US 4892549	(FIGGIE) Note knurled surface 30 in Figure 5	1 at least
X	US 4031570	(FREY) Note column 2 lines 15-20 and Figure	1 at least

		to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

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