

JOSE LLOREDA CAMACHO & CO.

Calle 72 No. 5-83 Piso 5, Bogotá, D.C. Tel: 6069700 Fax 6069701

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Señor

SUPERINTENDENTE DE INDUSTRIA Y COMERCIO

DIVISION DE NUEVAS CREACIONES

E. S. D.

SUPERINDUSTRIA Y COMERCIO
Radicación : 00029879 00000007 Folios: 1
Fecha (AND): 2005-12-07 16:51:43
Trámite : 002 PATENTES D 1 REGISTRO/ 593 IMPULSO F
Dependencia: 2020 DIVISION DE NUEVAS CREACIONES

Re: **P1.-THE GILLETTE COMPANY.-Solicitud de patente de Invención para "UN ELEMENTO DE CORTE, UNA ESTRUCTURA DE CORTE UNITARIA QUE COMPRENDE DICHO ELEMENTO DE CORTE, UN METODO PARA LA FABRICACION DE DICHO ELEMENTO DE CORTE Y UNA UNIDAD DE CORTE PARA UNA AFEITADORA DE SEGURIDAD".-Clase B62B B62B 21/58 .- Expediente número 00-029.079.-**

1. Me refiero a mi memorial de 16 de Diciembre de 2004.
2. Por medio del presente atentamente ruego a usted, se sirva pronunciarse en relación con la solicitud arriba nombrada, ya que desde el 31 de Enero de 2003, esto hace ya casi tres **(3) años**, que fue publicado el extracto de la presente solicitud en la Gaceta de la Propiedad Industrial No. 524, y el examen de patentabilidad correspondiente fue solicitado en su debido momento mediante memorial de 5 de Junio de 2003, sin que haya sido adelantado ningún otro trámite.
3. Cabe anotar que esta demora en el trámite acarrea grave perjuicio para mi representado.

Señor Superintendente,


ALICIA LLOREDA RICAURTE

T.P. 53.215

CR/fegv

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**SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
DIVISION DE NUEVAS CREACIONES**

2020
Bogotá, D.C ,

Abogada (señora)
ALICIA LLOREDÁ RICAURTE

ASUNTO	Radicación No.	<u>00-29079</u>
	Trámite	002
	Evento	001
	Actuación	430
	Oficio	3417
	Folios	25

Como resultado del examen de fondo, realizado con fundamento en el artículo 45 de la Comisión de la Comunidad Andina, se le comunica

1. Documentos estudiados:

Para el presente estudio se tuvo en cuenta el capítulo descriptivo comprendido en los folios 5 a 18, 83-84, el capítulo reivindicativo conformado por 24 cláusulas que se encuentran en los folios 19 a 21 y 85 y los dibujos comprendidos en los folios 23 a 25 de la solicitud en estudio

2. Objeto de la invención:

La presente invención se refiere a afetadoras de seguridad y está relacionada con una hoja formada por un material cerámico cristalino simple. La hoja presenta un filo cortante afilado y se provee elementos de soporte para el montaje y posicionado de la hoja de corte en una unidad de corte. Un elemento de protección se dispone hacia delante del filo cortante y se extiende paralelamente al mismo. Se puede proveer una pluralidad de elementos cortantes paralelos. La invención se refiere también a un método para fabricar el elemento de corte

La invención titulada, "Un elemento de corte, una estructura de corte unitaria que comprende dicho elemento de corte, un método para la fabricación de dicho elemento de corte y una unidad de corte para una afetadora de seguridad", se lleva a cabo de acuerdo con las características reivindicadas, donde el primer objeto de la solicitud dice: *"Un elemento de corte en o para una unidad de corte de una afetadora de seguridad, caracterizado por comprender un filo y porque se realiza en forma integral con unos elementos de soporte a partir de un material cerámico cristalino simple"*

La reivindicación 2 dice: *"Una estructura de corte unitaria en o para una unidad de corte de una afetadora de seguridad, caracterizada por comprender un elemento de corte con un filo, elementos de soporte para el montaje y posicionamiento del elemento de corte en*

una unidad de corte; y
 un elemento adicional dispuesto por delante del filo,
 en tanto dicho elemento de corte, los elementos de soporte y el elemento
 adicional están integralmente realizados en un material cristalino simple”.

La reivindicación 10 dice: “Una estructura de corte unitaria en o para una unidad
 de corte de una afeitadora de seguridad, caracterizada por comprender dos o más
 elementos de corte con filos, los cuales se fabrican en una sola pieza, junto con
 otros elementos que los interconectan, a partir de un material cerámico cristalino
 simple”.

La reivindicación 20 dice: “Un método de fabricación de un elemento de corte para
 una unidad de corte de una afeitadora de seguridad, caracterizado por
 comprender los pasos de:
 Provisión de un disco de material cristalino simple con una superficie que yace en
 un plano predeterminado de la estructura cristalográfica; y
 Remoción selectiva de material cristalino en la superficie por empleo de un
 proceso de decapado para obtener un elemento de corte plano inclinado a un
 ángulo agudo con relación al plano de la superficie y que posee un filo
 sustancialmente en el plano de la misma”.

El objeto de la invención definido anteriormente se clasificó de acuerdo con el IPC
 así: B26B21/58.

3. Determinación del estado de la técnica:

El artículo 16 de la decisión 486 de la comisión de la Comunidad Andina que
 establece que “El estado de la técnica comprenderá todo lo que haya sido
 accesible al público por una descripción escrita u oral, utilización, comercialización
 o cualquier otro medio antes de la fecha de presentación de la solicitud de patente
 o, en su caso, de la prioridad reconocida.

Solo para el efecto de la determinación de la novedad, también se considerará
 dentro del estado de la técnica, el contenido de una solicitud de patente en trámite
 ante la oficina nacional competente, cuya fecha de presentación o de prioridad
 fuese anterior a la fecha de presentación o de prioridad de la solicitud de patente
 que se estuviese examinando, siempre que dicho contenido esté incluido en la
 solicitud de fecha anterior cuando ella se publique o hubiese transcurrido el plazo
 previsto en el artículo 40”.

Consultadas las bases de datos y los archivos con que cuenta la entidad se
 encontró que antes del 23 de abril de 1999, fecha de prioridad reivindicada de la
 solicitud en estudio, dos documentos que podrían afectar la presente solicitud:

N°	Documento	Título	Fecha de publicación
D1	<u>US 5.048.191</u>	RAZOR BLADE TECHNOLOGY	17-09-1991
D2	<u>US 4.534.827</u>	CUTTING IMPLEMENT AND METHOD OF MAKING SAME	13-08-1985
D3	<u>US 5.018.274</u>	SAFETY RAZOR BLADE	28-05-1991

4. Evaluación de los requisitos de patentabilidad:

El artículo 14 de la Decisión 486 de la Comisión de la Comunidad Andina establece que *"Los Países Miembros otorgarán patentes para las invenciones, sean de producto o de procedimiento, en todos los campos de la tecnología, siempre que sean nuevas, tengan nivel inventivo y sean susceptibles de aplicación industrial"*.

En cumplimiento del artículo 14 de la Decisión 486, se procedió a evaluar el cumplimiento de los requisitos de novedad, nivel inventivo y aplicación industrial, con el fin de establecer la patentabilidad de la invención reivindicada en la solicitud en estudio.

Antes de entrar a realizar el análisis de patentabilidad de la presente invención, se le recuerda al solicitante que:

- a) Las reivindicaciones deberán delimitar claramente la invención respecto al estado de la técnica o tecnología anterior, de modo que se observe en forma concisa lo nuevo que se está aportando a la tecnología y todo aquello que lo hace diferente de lo ya existente.
- b) El tenor de las reivindicaciones es el que determina el alcance de la protección conferida por la patente (Art. 51). *Por ello, al analizar la novedad se deben interpretar las reivindicaciones tomando el sentido más amplio de las definiciones empleadas.*
- c) Cuando se ha establecido la falta de novedad de la invención, no es necesario evaluar el nivel inventivo, dado que no existe diferencias entre la invención y el estado de la técnica.

Evaluación de la novedad:

El artículo 16 de la decisión 486 de la comisión de la Comunidad Andina que establece que *"El estado de la técnica comprenderá todo lo que haya sido accesible al público por una descripción escrita u oral, utilización, comercialización o cualquier otro medio antes de la fecha de presentación de la solicitud de patente o, en su caso, de la prioridad reconocida."*

Solo para el efecto de la determinación de la novedad, también se considerará dentro del estado de la técnica, el contenido de una solicitud de patente en trámite ante la oficina nacional competente, cuya fecha de presentación o de prioridad fuese anterior a la fecha de presentación o de prioridad de la solicitud de patente que se estuviese examinando, siempre que dicho contenido esté incluido en la solicitud de fecha anterior cuando ella se publique o hubiese transcurrido el plazo previsto en el artículo 40".

De acuerdo con la definición de novedad del Artículo 16 de la Decisión 486 de la Comisión de la Comunidad Andina y basándonos en el objeto de la invención se realizó el siguiente análisis:

- 1) La presente invención se lleva a cabo de acuerdo con las características reivindicadas, donde la reivindicación 1 dice: *"Un elemento de corte en o para una unidad de corte de una afeitadora de seguridad, caracterizado por comprender un filo y porque se realiza en forma integral con unos elementos"*

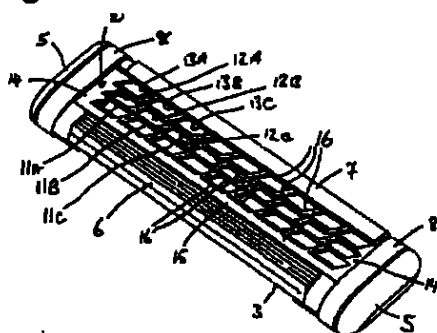
de soporte a partir de un material cerámico cristalino simple”.

La reivindicación 20 dice: “Un método de fabricación de un elemento de corte para una unidad de corte de una afeitadora de seguridad, caracterizado por comprender los pasos de:

Provisión de un disco de material cristalino simple con una superficie que yace en un plano predeterminado de la estructura cristalográfica; y

Remoción selectiva de material cristalino en la superficie por empleo de un proceso de decapado para obtener un elemento de corte plano inclinado a un ángulo agudo con relación al plano de la superficie y que posee un filo sustancialmente en el plano de la misma”.

Figura 1 de la solicitud en estudio



- 2) El documento US 5.048.191 (D1) se relaciona con los procesos para producir y tratar hojas de afeitar de cerámica o herramientas de corte similares con un filo agudo y con máquinas de afeitar mejoradas.

Al comparar elemento por elemento de la invención tal como está definido por la reivindicación 1 de la solicitud en estudio con las características del documento D1, vemos que D1 (ver columna 2, líneas 43, 44; columna 3, línea 64 – columna 4, línea 11; reivindicaciones 1, 3) describe un elemento de corte, que comprende:

- Un filo con elementos de soporte a partir de un material cerámico cristalino (ver columna 2, líneas 43, 44).

- 3) El documento US 4.534.827 (D2) se relaciona con instrumentos de corte hechos de materiales de solo cristal y más particularmente con los instrumentos de corte y los métodos de fabricación, las láminas con agudeza, fricción mínima de la lámina, y la resistencia alta al desgaste.

Al comparar la reivindicación 20 de la solicitud en estudio con las características del documento D2, vemos que D2 describe un método de fabricación de un elemento de corte:

Provisión de un disco de material cristalino simple con una superficie que yace en un plano predeterminado de la estructura cristalográfica; y remoción selectiva de material cristalino en la superficie por empleo de un proceso de decapado para obtener un elemento de corte plano inclinado a un ángulo agudo con relación al plano de la superficie y que posee un filo sustancialmente en el plano de la misma (ver columna 1, línea 1 – línea 21; columna 8, línea 60 - columna 9, línea 19; columna 12, línea – línea 18; reivindicación 1).

- 4) Realizada la comparación del documento D1 y D2 con la presente solicitud en estudio, se observa que dichos documentos contienen las características de las reivindicaciones 1, 10 y 20 de la presente solicitud en estudio; por lo tanto, el objeto de la solicitud en estudio podría ser idéntico a lo comprendido en el estado de la técnica, con lo cual quedaría desvirtuada la novedad de esta.

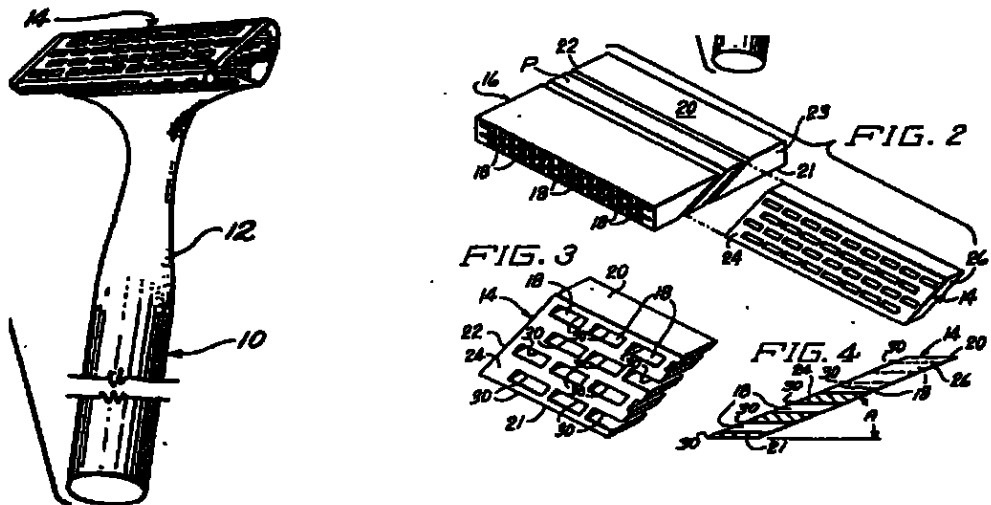
Evaluación del Nivel Inventivo

El artículo 18 de la decisión 486 de la Comisión de la Comunidad Andina dispone *"Se considerará que una invención tiene nivel inventivo, si para una persona del oficio normalmente versada en la materia técnica correspondiente, esa invención no hubiese resultado obvia ni se hubiese derivado de manera evidente del estado de la técnica."*

Basándonos en el análisis de la invención y del estado de la técnica, se realizó el siguiente análisis:

- 1) La reivindicación 2 dice: *"Una estructura de corte unitaria en o para una unidad de corte de una afeitadora de seguridad, caracterizada por comprender:
un elemento de corte con un filo;
elementos de soporte para el montaje y posicionamiento del elemento de corte en una unidad de corte; y
un elemento adicional dispuesto por delante del filo,
en tanto dicho elemento de corte, los elementos de soporte y el elemento adicional están integralmente realizados en un material cristalino simple"*.
- 2) El documento US 5.018.274 (D3) se relaciona con una lámina para el uso de una maquina de afeitar, y más particularmente con una lámina de cerámica para el uso en una maquina de afeitar y del método de fabricación (ver descripción, figuras).

Figuras del documento US 5.018274 (D3)



- 3) La reivindicación 2 podría verse afectada por nivel inventivo por las siguientes razones:
 - D3 sugiere elementos de corte con filo (ver figuras)

- D3 sugiere elementos de soporte para el montaje y posicionamiento del elemento de corte en la unidades de corte
- D1 sugiere que los elementos de corte, soporte estén realizados en un material cristalino simple (ver columna 2, líneas 43-44)

4) De acuerdo con lo anterior, se puede concluir que con las enseñanzas de los documentos D3 – D1 y los conocimientos de una persona versada en la materia se podría llegar a obtener una estructura de corte que comprende elemento de corte con las características de la solicitud en estudio y lograr el objetivo de la invención.

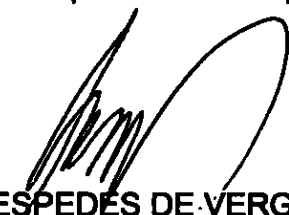
En consecuencia, se afirma que los documentos presentados como anterioridades afectan el requisito de nivel inventivo, y por lo tanto, se considera que la invención de la solicitud en estudio no cumple con el requisito de nivel inventivo definido en el artículo 18 de la Decisión 486 de la Comisión de la Comunidad Andina.

En conclusión, los requisitos de patentabilidad de la presente solicitud se podrían ver afectados así:

N°	Documento	Reivindicaciones afectadas	Requisito que afecta
D1	<u>US 5.048.191</u>	1, 10 a 19 2 a 9	Novedad Nivel Inventivo
D2	<u>US 4.534.827</u>	20 a 23	Nivel Inventivo
D3	<u>US 5.018.274</u>	2 a 9	Nivel Inventivo

En cumplimiento del artículo 45 de la Decisión 486 de la Comisión de la Comunidad Andina, se le indica que debe dar respuesta dentro del término de sesenta días contados a partir de la fecha de la notificación de la presente comunicación. En caso de no dar respuesta al presente requerimiento o si a pesar de la respuesta subsistieran los impedimentos para la concesión, se denegará la patente.

Notifíquese el presente oficio conforme a lo dispuesto en el numeral 5.2, literal e), del capítulo quinto del título primero de la Circular Unica N° 10 de 2001.



ALIX CESPEDES DE VERGEL.
Jefe de la División de Nuevas Creaciones

El anterior requerimiento fue notificado por fijación en lista, de fecha 15 MAR 2007

CONCEPTO TÉCNICO Número: 409		EXAMINADOR TÉCNICO Código:202018
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[54] RAZOR BLADE TECHNOLOGY

[75] Inventor: Steve S. Hahn, Wellesley Hills, Mass.

[73] Assignee: The Gillette Company, Boston, Mass.

[21] Appl. No.: 599,267

[22] Filed: Oct. 16, 1990

Related U.S. Application Data

[63] Continuation of Ser. No. 535,741, Jun. 8, 1990, abandoned.

[51] Int. Cl.³ B26B 21/54

[52] U.S. Cl. 30/346.54; 76/104.1;
76/DIG. 8

[56] References Cited

U.S. PATENT DOCUMENTS

2,555,214 5/1951 Wallach .
3,514,856 6/1970 Camp .
3,543,402 12/1970 Seager .
3,607,483 9/1971 Bailey .
3,703,766 11/1972 Tibbels .
3,761,373 9/1973 Sastri .
3,834,265 9/1974 Tafapolsky .
3,911,579 10/1975 Lane .

4,534,827 8/1985 Henderson .
4,702,004 10/1987 Haythornthwaite .

FOREIGN PATENT DOCUMENTS

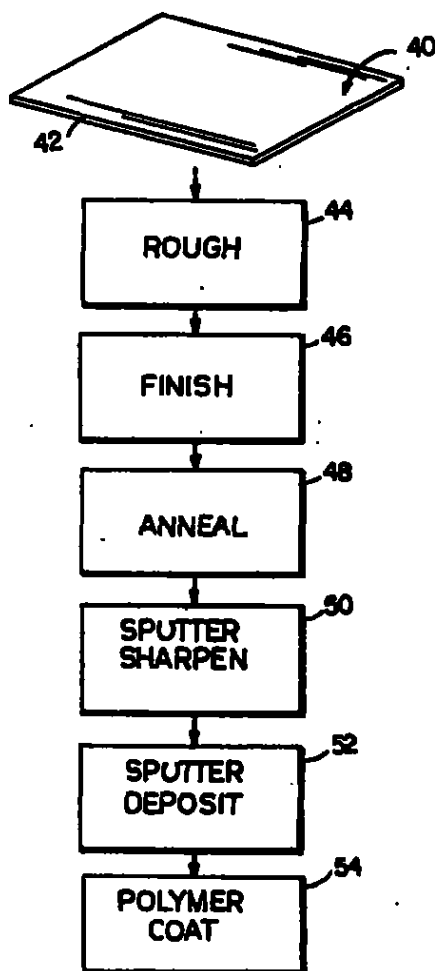
6058805 4/1985 Japan .
6058806 4/1985 Japan .
1423831 2/1976 United Kingdom .

Primary Examiner—Douglas D. Watts
Attorney, Agent, or Firm—Fish & Richardson .

[57] ABSTRACT

A process for forming a razor blade includes the steps of providing a ceramic substrate, mechanically abrading an edge of the ceramic substrate to form a sharpened edge thereon with facets that have an included angle of less than thirty degrees; thermally processing the mechanically abraded edge to reduce surface raggedness and subsurface defects; and sputter-sharpening the sharpened edge to provide supplemental facets that have an included angle of more than forty degrees and define a tip radius of less than five hundred angstroms. The resulting blade exhibit excellent shaving properties.

31 Claims, 1 Drawing Sheet



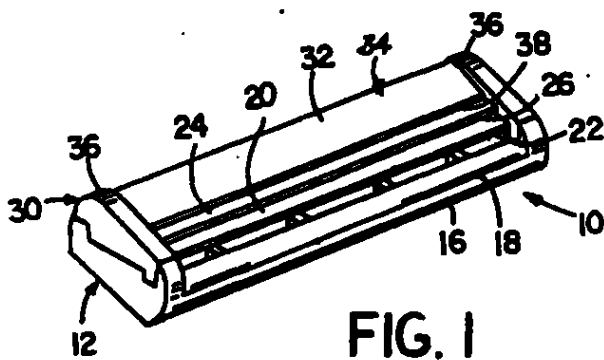


FIG. 1

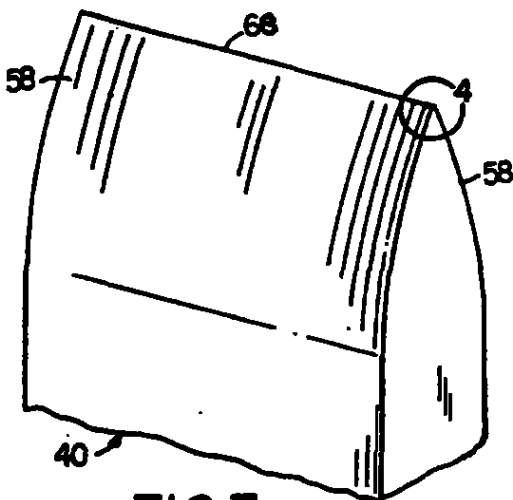


FIG. 3

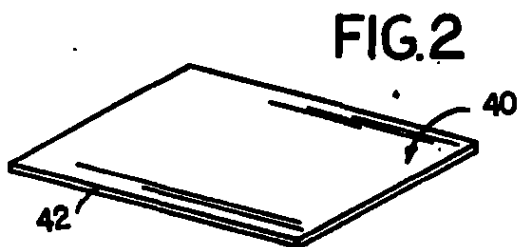


FIG. 2

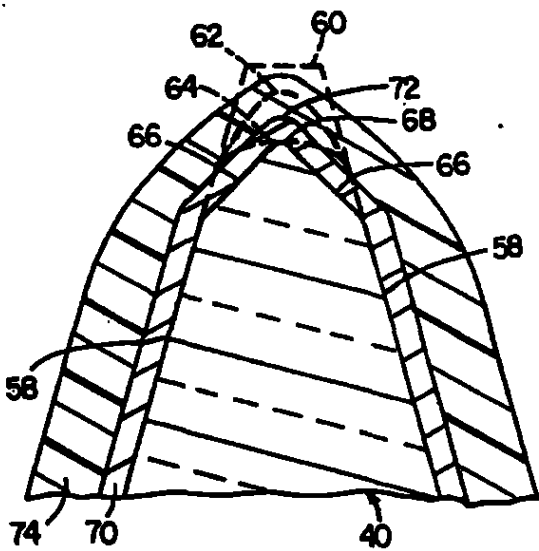
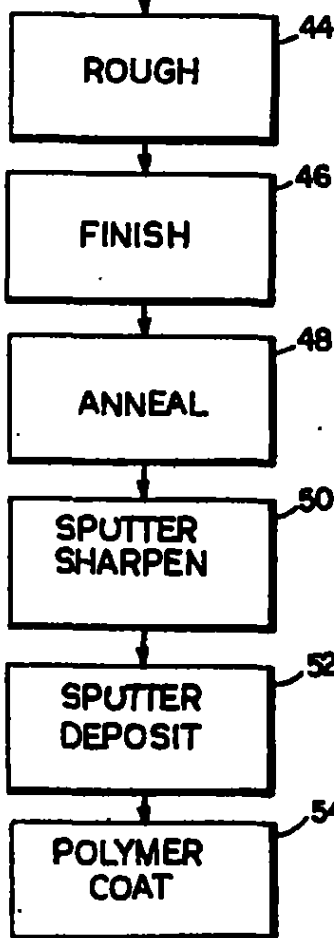


FIG. 4

RAZOR BLADE TECHNOLOGY

This is a continuation of U.S. Pat. No. 535,741, filed June 8, 1990, now abandoned.

This invention relates to processes for producing and treating ceramic razor blades or similar cutting tools with sharp and durable cutting edge and to improved razors and razor blades.

While razor blades are conventionally produced from steel strips in which a sharpened edge is formed through a series of mechanical grinding and honing operations, ceramic materials have also been proposed for razor blades because of their desirable properties of high hardness, mechanical strength and corrosion resistance. While steel can exhibit increased strength in the worked area (e.g. the sharpened edge) from the mechanical cold working (e.g. finish-honing operations), ceramic materials in similar mechanical sharpening operations often exhibit weaker strength in the worked area because of microscale, subsurface defects induced by the considerable stress that accompany mechanical grinding and finish honing and tend to be more susceptible than steel razor blade edges to fracture-type breakdown of the cutting edges during shaving.

In accordance with one aspect of the invention, there is provided a process for forming a razor blade that includes the steps of providing a ceramic substrate, mechanically abrading an edge of the ceramic substrate to form a sharpened edge thereon that has an included angle of less than thirty degrees and a tip radius (i.e. the estimated radius of the largest circle that may be positioned within the ultimate tip of the edge when such ultimate tip is viewed under a scanning electron microscope at magnifications of at least 25,000) of less than twelve hundred angstroms; and sputter-sharpening the sharpened edge to form supplemental facets that have widths of less than one micrometer, have an included angle greater than forty degrees, define an ultimate tip radius of less than five hundred angstroms and form a cutting edge. The resulting blades exhibit excellent shaving properties and long shaving life.

In preferred processes, the ceramic substrate is abraded in two-step sequence of rough-honing and finish-honing with diamond abrasive material that minimizes mechanically-induced subsurface defects, (instead of a more conventional three-step steel sharpening sequence that includes a grinding step) to form a sharpened edge. The mechanically abraded edge of the ceramic substrate then is subjected to heat-treatment at a temperature of at least 1000° C., herein referred to as "annealing", that reduces surface raggedness and subsurface defects resulting from the mechanical abrasion sequence and to produce a micro-scale plateau-like top of less than about 0.2 micrometers width at the ultimate tip. The annealing may be performed in air or in other gaseous environments and the duration of annealing may decrease with higher annealing temperatures, for example, with an oxygen-hydrogen annealing flame. The plateau-like top of the blade edge then is sputter-sharpened by ion-beam etching to form supplemental facets of width in the range of 0.1-0.5 micrometers; to further reduce subsurface defect areas, and at the same time to reduce the ultimate tip radius of the sharpened edge by a factor of at least about two, as well as to provide a clean edge surface on which a metal layer that preferably contains chromium is sputter-deposited. An

adherent and friction-reducing polymer coating is then applied on the metal-coated cutting edge.

In a particular process, the ceramic material is single crystal alumina (sapphire) with a thickness of less than 0.5 millimeter, and a bend strength in excess of 700 MPa; the rough-honing operation employs grinding wheels with diamond particles with grain sizes of less than twenty micrometers and the finish-honing operation employs sharpening wheels with an average diamond particle size of about one micrometer; annealing of the mechanically sharpened edge is carried out in air at a temperature of about 1550° C. for about one hour; the sputter-sharpened facets of the ultimate edge have widths in the range of 0.2-0.5 micrometer and an effective included angle of about seventy degrees; the sputter-coated metallic layer has a thickness of less than five hundred angstroms, and the polymer layer has a thickness of less than ten micrometers.

In accordance with another aspect of the invention, there is provided a razor blade that includes a ceramic substrate with mechanically abraded and thermally annealed facets generally parallel (that is, within at least thirty degrees and preferably within ten degrees) to its C crystallographic axis and supplemental sputter-sharpened facets that have an effective included angle substantially greater than the included angle of the mechanically abraded sharpened facets, and that define a sputter-sharpened cutting edge with an ultimate tip radius of less than five hundred angstroms.

In particular embodiments, the razor blade substrate is single crystal alumina (sapphire), and has a bend strength in excess of 700 MPa; the mechanically abraded facets have an effective included angle of less than twenty degrees; the sputter-sharpened facets of the ultimate edge have widths of about 0.3 micrometer, an effective included angle greater than forty degrees, and substantial uniformity in ultimate tip radius along the length of the entire cutting edge. A sputter-deposited metallic layer on the cutting edge is less than five hundred angstroms thickness, and an adherent, friction-reducing polymer coating on the metal-coated ceramic cutting edge is less than ten micrometers in thickness.

Preferably, the ceramic substrate is single crystal material selected from silicon carbide, silicon nitride, zirconia and alumina, particularly preferred substrate materials being high-purity alumina and hot-isostatically-pressed tetragonal zirconia. The heat-treatment reduces surface raggedness and subsurface defects resulting from the mechanical abrasion sequence and the sputter-sharpening further reduces such subsurface defect areas, and reduces the ultimate tip radius of the sharpened edge.

The resulting large facet angle (immediately adjacent the tip), low tip radius annealed blades with sputter-deposited metallic layer and adherent, friction-reducing polymer coating exhibit strength and excellent shaving characteristics.

In accordance with another aspect of the invention, there is provided a shaving unit that comprises at least one blade and blade support structure that has external guard and cap surfaces for engaging the user's skin respectively ahead and rearwardly of the blade edge or edges. Razor blade structure secured to the support structure includes a ceramic substrate with mechanically abraded facets that have a width of at least about 0.1 millimeter and an included angle of less than thirty degrees, and a sputter-sharpened cutting edge of tip radius less than about five hundred angstroms that is

defined by facets that have an effective included angle substantially greater than the included angle of the mechanically abraded facets, the sputter-sharpened cutting edge being disposed between the skin-engaging surfaces. Preferably, the razor blade structure includes two ceramic substrates, and each ceramic substrate is thermally annealed and has a sputter-sharpened cutting edge of tip radius less than about five hundred angstroms that is defined by facets that have an effective included angle of at least forty degrees, and the sputter-sharpened cutting edges being disposed parallel to one another between the skin-engaging surfaces.

In a particular embodiment, the ceramic substrate material is alumina and has a bend strength in excess of 300 MPa, each sputter-sharpened facet immediately adjacent the cutting edge has a width of about 0.3 micrometer and an effective included angle of about seventy degrees, a sputter-deposited metal layer is on the cutting edge, and an adherent polymer coating is on the metal coated cutting edge, the sputter-deposited metal layer has a thickness of less than five hundred angstroms, and the adherent polymer coating on the metal layer has a thickness of less than ten micrometers.

The shaving unit may be of the disposable cartridge type adapted for coupling to and uncoupling from a razor handle or may be integral with a handle so that the complete razor is discarded as a unit when the blade or blades becomes dulled. The front and rear skin engaging surfaces cooperate with the blade edge (or edges) to define the shaving geometry. Particularly preferred shaving units are of the types shown in U.S. Pat. No. 3,876,563 and in U.S. Pat. No. 4,351,916.

Other features and advantages will be seen as the following description of particular embodiments progresses, in conjunction with the drawings, in which:

FIG. 1 is a perspective view of a shaving unit in accordance with the invention;

FIG. 2 is a flow diagram indicating a sequence of steps in manufacturing a razor blade in accordance with the invention;

FIG. 3 is a perspective view of a portion of a razor blade in accordance with the invention; and

FIG. 4 is an enlarged diagrammatic view (as viewed in a scanning electron microscope originally at about 50,000 magnification) of the ultimate tip of the razor blade shown in FIG. 3.

DESCRIPTION OF PARTICULAR EMBODIMENTS

The shaving unit 10 shown in FIG. 1 includes a base or platform member 12 molded of high impact polystyrene for attachment to a razor handle and guard structure 16 that defines a transversely extending forward skin engaging surface 18. On the upper surface of platform 12 are disposed ceramic leading blade 20 having a sharpened edge 22, ceramic following blade 24 having sharpened edge 26, and spacer structure that maintains blades 20 and 24 in spaced relation. Cap member 30 is molded of high impact polystyrene and has body portion 32 that defines skin engaging surface 34 that extends transversely between forwardly projecting end walls 36 and has a front edge 38 that is disposed rearwardly of blade edge 26.

Blades 20 and 24 are manufactured in accordance with the sequence shown in FIG. 2. Each blade 20, 24 is formed from a ceramic razor blade blank 40 of single crystal aluminum oxide (sapphire) that has a width of about 0.6 centimeter, a length of about 3.8 centimeters,

a thickness of about 0.1 millimeter, and edge surface 42 parallel to its C crystallographic axis that is to be sharpened to a cutting edge.

With reference to FIG. 2, blank 40 is subjected to a sequence of edge forming operations including rough-honing operation 44; finish-honing operation 46; annealing operation 48; and sputter-sharpening operation 50 to form a blade edge of cross sectional configuration as diagrammatically indicated in the perspective view of FIG. the blade is then subjected to sputter-depositing operation 52. The blade has rough-honed facets 58 of about 0.5 millimeter width and an included angle of about nine degrees and a flat top diagrammatically indicated at 60 (FIG. 4) that is modified by finish-honing 46 to form a tip 62 of about 700 angstroms tip radius (FIG. 4). After reduction of surface raggedness and of subsurface defects by annealing 48 and sputter-sharpening 50, the resulting ultimate tip 68 defined by facets 66 has an included angle of about seventy degrees and a tip radius of about 300 angstroms.

In the rough-honing operation 44, the blade blank 40 is fed, at a transfer speed of about 360 centimeters per minute, past an abrasive wheel (with diamond particles of 8-16 micrometers grain size) with an oil flow of 1.8 liters per minute and the wheel rotating into the blade edge at 1100 RPM, a set angle of 4.5 degrees (the angle between the plane of the blade 40 and a tangent to the wheel where the blade makes contact with the wheel), a sharpening infeed of about 0.5 millimeter (the blade deflection by the sharpening wheel), and a spring force of about one kilogram, to form rough-hone facets 58 that have an included angle of about nine degrees and a width of about 0.5 millimeter and relatively flat top 60 that has a width of about ten micrometers.

The rough-honed facets 58 are then subjected to a finish-honing operation at stage 46 in which the blade edge is abraded to form tip 62 of about 600-800 angstroms radius. The sharpening wheels at the finish-hone stage 46 have diamond particles with an average grain size of one micron and are rotated at a speed of 1130 RPM away from the blade 40 with a set angle of about 8 degrees, a sharpening infeed of 0.2 millimeter and a spring force of about one kilogram, and the blade 40 is fed at a transfer speed of about 170 centimeters per minute.

After the mechanically sharpened blades 40 have been degreased in methylene chloride and solvent-washed ultrasonically in Freon, the degreased and particulate-free blades are placed in a tube furnace and annealed at 1550° C. for one hour in air. Such annealing treatment of the mechanically sharpened, ceramic edge produces significant change in the tip region such that the annealed ultimate tip now has a micro-scale, plateau-like top region diagrammatically indicated at 64 along the length of the blade edge that is about 1000 angstroms in width. Edge surface raggedness is reduced, and subsurface defects that were created during the mechanical honing operations (as evidenced by transmission electron microscopy analysis) are also reduced.

The annealed blades 40 are then placed in a sputtering chamber with an elongated cathode, the blade edges being normal to the cathode at a blade edge-to-cathode distance of about seven centimeters. The sputtering chamber is evacuated to a pressure of equal to or better than 2×10^{-6} torr, and argon is introduced to attain a sputtering gas pressure of ten millitorr. 13.56 megahertz RF power is applied to establish a stable plasma with

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200 watts RF forward power and a sputter-sharpening duration of about 135 seconds to produce sputter-sharpened facets 66 that have widths of about 0.3 micrometers and an included angle of about seventy degrees and an ultimate tip 68 radius of about 300 angstroms as diagrammatically indicated in FIG. 4. Edge surface raggedness and subsurface defects that were created during the mechanical honing operations (as evidenced by transmission electron microscopy analysis) are further reduced.

Following the sputter-sharpening procedure 50, the sputter unit is switched from sputter-sharpening (ion-beam etching) mode to deposition mode using a matching network selector; a plasma is ignited at 400 watts and ten millitorr pressure, and a chromium-platinum target is presputtered for about five minutes with a substrate shielded between the blades and the target. Upon completion of presputtering, the substrate shield is retracted and sputtered atoms of chromium and platinum are deposited on the sharpened blade edges to form a stabilizing metallic layer 70 of about three hundred angstroms thickness and a tip radius of about 350 angstroms as diagrammatically indicated in FIG. 4.

A coating 72 of polytetrafluoroethylene telomer is then applied to the sputter-coated edges of the blades in accordance with the teaching of U.S. Pat. No. 3,518,110. This process involves heating the blades in an argon environment and providing on the cutting edges of the blades an adherent and friction-reduction polymer coating 74 of solid PTFE as diagrammatically indicated in FIG. 4.

A diagrammatic view of the resulting blade edge is shown in FIG. 4. The radius of the modified (sputter-sharpened) tip 68 is about three hundred angstroms, the included angle of the sputter-sharpened surfaces 66 forming the modified tip 68 is about seventy degrees and the included angle of the mechanically abraded and annealed facets 58 is about nine degrees. Resulting ceramic blades 20, 24 are assembled in razor 10. The razor exhibits excellent shaving properties and shaving life.

While particular embodiments of the invention have been shown and described, various modifications will be apparent to those skilled in the art, and therefore, it is not intended that invention be limited to the disclosed embodiment, or to details thereof, and departures may be made therefrom within the spirit and scope of the invention.

What is claimed is:

1. A process for forming a razor blade comprising the steps of

providing a ceramic substrate,
mechanically abrading said ceramic substrate in a sequence of rough-honing and finish-honing steps with diamond abrasive materials to form a sharpened edge thereon with facets that have an included angle of less than thirty degrees and a tip radius of less than twelve hundred angstroms; and sputter-sharpened said edge to form a cutting edge defined by supplemental facets that are less than one micrometer in width and have an included angle greater than forty degrees.

2. The process of claim 1 wherein said ceramic substrate material is selected from the group consisting of silicon carbide, silicon nitride, zirconia, and alumina.

3. The process of claim 1 wherein said ceramic substrate has a bend strength in excess of 300 MPa.

4. The process of claim 3 wherein said ceramic substrate is of single crystal material and has a bend strength in excess of 700 MPa.

5. The process of claim 5 wherein said rough-honing step forms facets that have an included angle of less than twenty degrees.

6. The process of claim 1 wherein said step of mechanically abrading said ceramic substrate forms a sharpened edge thereon that has an ultimate tip radius in the range of 600 to 800 angstroms.

7. A process for forming a razor blade comprising the steps of

providing a ceramic substrate,
mechanically abrading said ceramic substrate to form a sharpened edge thereon with facets that have an included angle of less than thirty degrees and a tip radius of less than twelve hundred angstroms; sputter-sharpening said edge to form a cutting edge defined by supplemental facets that are less than one micrometer in width and have an included angle greater than forty degrees; sputter depositing a chromium-containing metal layer on said cutting edge; and then applying an adherent polymer coating on said metal coated cutting edge.

8. The process of claim 7 wherein said sputter-deposited metal layer on said cutting edge has a thickness of less than five hundred angstroms, and said adherent polymer coating on said metal coated cutting edge has a thickness of less than ten micrometers.

9. A process for forming a razor blade comprising the steps of

providing a ceramic substrate,
mechanically abrading said ceramic substrate to form a sharpened edge thereon with facets that have an included angle of less than thirty degrees and a tip radius of less than twelve hundred angstroms; and sputter-sharpening said edge to form a cutting edge defined by supplemental facets that are less than one micrometer in width and have an included angle greater than forty degrees, the sputter-sharpened surfaces immediately adjacent said cutting edge having widths in the range of 0.1-0.5 micrometer, an effective included angle substantially greater than the included angle of said mechanically-abraded facets, and providing a tip radius of less than five hundred angstroms.

10. The process of claim 9 wherein said ceramic substrate material is selected from the group consisting of alumina and zirconia.

11. The process of claim 1 and further including the step of annealing said mechanically-abraded ceramic substrate to modify the ultimate tip region and reduce subsurface defects and surface irregularities adjacent said sharpened edge.

12. The process of claim 11 wherein said ceramic substrate material is selected from the group consisting of silicon carbide, silicon nitride, zirconia, and alumina.

13. The process of claim 11 wherein said ceramic substrate is of single crystal material and has a bend strength in excess of 700 MPa.

14. A process for forming a razor blade comprising the steps of

providing a ceramic substrate,
mechanically abrading said ceramic substrate to form a sharpened edge thereon with facets that have an included angle of less than thirty degrees and a tip radius of less than twelve hundred angstroms; said

step of mechanically abrading said ceramic substrate including a rough-honing step that forms facets that have an included angle of less than twenty degrees and a finish-honing step that forms a sharpened edge that has an ultimate tip radius in the range of 600 to 800 angstroms, annealing said mechanically-abraded ceramic substrate to modify the ultimate tip region and reduce subsurface defects and surface irregularities adjacent said sharpened edge; and

sputter-sharpening said edge to form a cutting edge defined by supplemental facets that are less than one micrometer in width and have an included angle greater than forty degrees.

15. The process of claim 11 wherein said ceramic substrate material is single crystal material selected from the group consisting of alumina and zirconia that has a bend strength in excess of 700 MPa, said ceramic substrate is mechanically abraded in a sequence of rough-honing and finish-honing steps with diamond abrasive material with grain size of less than twenty micrometers and further including the steps of sputter depositing a metallic layer on said cutting edge to a thickness of less than five hundred angstroms, and then applying an adherent polymer coating on said metal coated cutting edge to a thickness of less than ten micrometers.

16. The process of claim 11 wherein said annealing is at a temperature of at least 1000° C.

17. A razor blade comprising a ceramic substrate with mechanically-abraded facets that have a width of at least about 0.1 millimeter and an included angle of less than thirty degrees, a sputter-sharpened cutting edge of tip radius less than about five hundred angstroms that is defined by supplemental sputter-sharpened facets that have an effective included angle substantially greater than the included angle of said mechanically abraded facets, a sputter-deposited metal layer on said sputter-etched cutting edge, and an adherent polymer coating on said metal coated cutting edge.

18. The razor blade of claim 17 wherein said mechanically-abraded facets are thermally annealed.

19. The razor blade of claim 17 wherein said sputter-sharpened surfaces immediately adjacent said cutting edge have widths in the range of 0.1–0.5 micrometer.

20. The razor blade of claim 17 wherein said sputter-deposited metal layer on said sputter-sharpened cutting edge has a thickness of less than five hundred angstroms, and said adherent polymer coating on said metal coated cutting edge has a thickness of less than ten micrometers.

21. A razor blade comprising a ceramic substrate with mechanically-abraded facets that have a width of at least about 0.1 millimeter and an included angle of less than thirty degrees, and a sputter-sharpened cutting edge of tip radius less than about five hundred angstroms that is defined by supplemental sputter-sharpened facets that have an effective included angle substantially greater than the included angle of said mechanically abraded facets, said cutting edge being generally parallel to the C crystallographic axis of said substrate.

22. The razor blade of claim 21 wherein said ceramic substrate material is selected from the group consisting of silicon carbide, silicon nitride, zirconia, and alumina and has a bend strength in excess of 300 MPa.

23. The razor blade of claim 22 wherein each said sputter-sharpened facet immediately adjacent said cut-

ting edge has a width of about 0.3 micrometer and an effective included angle of at least forty degrees, and further including a sputter-deposited metal layer on said cutting edge, and an adherent polymer coating on said metal coated cutting edge, said sputter-deposited metal layer having a thickness of less than five hundred angstroms, and said adherent polymer coating on said metal layer having a thickness of less than ten micrometers.

24. The razor blade of claim 21 wherein said mechanically abraded facets are thermally annealed at a temperature of at least 1000° C.

25. A shaving unit comprising support structure that defines spaced skin-engaging surfaces, and razor blade structure secured to said support structure, said razor blade structure including a ceramic substrate with mechanically-abraded facets that have a width of at least about 0.1 millimeter and an included angle of less than thirty degrees, and a sputter-sharpened cutting edge of tip radius less than about five hundred angstroms that is defined by facets that have an effective included angle substantially greater than the included angle of said mechanically-abraded facets, a sputter-deposited metal layer on said sputter-etched cutting edge, and an adherent polymer coating on said metal coated cutting edge, said sputter-sharpened cutting edge being disposed between said skin-engaging surfaces.

26. The shaving unit of claim 25 wherein said razor blade structure includes two ceramic substrates, and each said ceramic substrate has a sputter-sharpened cutting edge of tip radius less than about five hundred angstroms that is defined by facets that have an effective included angle substantially greater than the included angle of said mechanically-abraded facets, said sputter-sharpened cutting edges being disposed parallel to one another between said skin engaging surfaces.

27. The shaving unit of claim 25 wherein said sputter-sharpened surfaces immediately adjacent said cutting edge have widths in the range of 0.1–0.5 micrometer.

28. The razor blade of claim 25 wherein said mechanically-abraded facets are thermally annealed.

29. The shaving unit of claim 28 wherein said razor blade structure includes two ceramic substrates, and each said ceramic substrate has a sputter-sharpened cutting edge of tip radius less than about five hundred angstroms that is defined by facets that have an effective included angle substantially greater than the included angle of said mechanically abraded facets, said sputter-sharpened cutting edges being disposed parallel to one another between said skin-engaging surfaces.

30. The shaving unit of claim 29 wherein said ceramic substrate material is selected from the group consisting of silicon carbide, silicon nitride, zirconia, and alumina and has a bend strength in excess of 700 MPa.

31. A shaving unit comprising support structure that defines spaced skin-engaging surfaces, and razor blade structure secured to said support structure, said razor blade structure including two ceramic substrates of material selected from the group consisting of silicon carbide, silicon nitride, zirconia, and alumina and having a bend strength in excess of 700 MPa, each said substrate having thermally annealed mechanically-abraded facets that have a width of at least about 0.1 millimeter and an included angle of less than thirty degrees, and a sputter-sharpened cutting edge of tip radius less than about five hundred angstroms that is defined by facets that have an effective included angle substantially greater than the included angle of said mechanically-abraded facets, each said sputter-shar-

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pened facet immediately adjacent said cutting edge having a width of about 0.3 micrometer and said sputter-sharpened facets having an effective included angle of at least forty degrees, a sputter-deposited metal layer of thickness less than five hundred angstroms on each

said cutting edge, and an adherent polymer coating of thickness of less than ten micrometers on each said metal layer, said sputter-sharpened cutting edge being disposed between said skin-engaging surfaces.

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[54] CUTTING IMPLEMENT AND METHOD OF MAKING SAME

[76] Inventor: Donald W. Henderson, 20 Woodlane Rd., Ithaca, N.Y. 14850

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[58] Field of Search 156/625, 647, 654, 667; 30/346, 350, 346.53, 346.54; 29/576 T; 128/305; 423/625; 252/79.2

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Primary Examiner—Edward C. Kimlin

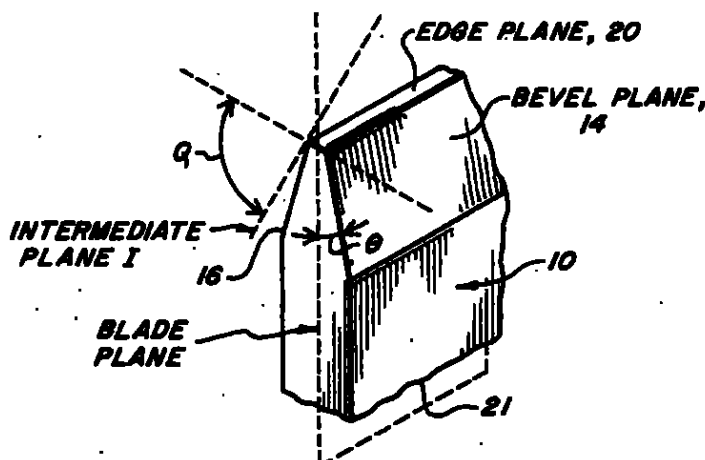
Assistant Examiner—Ramon R. Hoch

Attorney, Agent, or Firm—Weingarten, Schurgin Gagnebin & Hayes

[57] ABSTRACT

A cutting tool, preferably in the form of a scalpel, microtome or razor blade is fabricated from single crystal material such as aluminum oxide with a preferential etching process to produce a radius of curvature less than 100 Angstroms on the edge. Depending upon the etchant, the crystallographic orientation of the blank and the resulting different etch rates on blade surfaces, the preferential etching process not only sharpens a preformed edge but also, in one embodiment, produces an opposing edge which meets the sharpened edge at a point, thereby to produce a particularly efficient scalpel blade configuration having two cutting edges converging at a point for plunging and cutting. With respect to the sharpening of the cutting edge, consistent with all other blade forming requirements, the subject blade is made to a maximum sharpness by utilizing a maximum ratio of bevel plane etch rate to edge plane etch rate. This maximum ratio maximizes the edge sharpness when a steady state etching geometry has been achieved. In one embodiment, and for a given edge sharpness, blade drag is minimized by selecting the crystallographic orientation and etchant such that the etchant chemically polishes the bevels and maintains the planarity of the bevel planes. In order to achieve identical etching of the bevels meeting at the blade edge and thus maintain original blade geometry, the blank can be oriented such that the edge forming planes are crystallographically identical planes.

8 Claims, 9 Drawing Figures



CUTTING IMPLEMENT AND METHOD OF MAKING SAME

FIELD OF INVENTION

This invention relates to cutting implements made of single crystal materials and more particularly to cutting instruments and the methods of manufacture, the blades having exceptional sharpness, minimal blade drag, and exceptionally high wear resistance.

BACKGROUND OF THE INVENTION

While the subject invention will be described in connection with the manufacture of exceptionally sharp scalpels, it will be appreciated that the invention discussed herein relates to any cutting implement, the sharpness of which and the durability of which is of importance. As such, the cutting implements described herein include microtomes, razor blades, and knives as well as surgical scalpels.

The best blades produced by current metallic technology have an edge radius of curvature of approximately 500 Angstroms. Diamond blades have been produced which have an edge radius of curvature of approximately 400 Angstroms. More recently, ruby blades have been produced with an edge radius of curvature of 350 Angstroms. All of the above blades have been produced by conventional lapping procedures.

While U.S. Pat. Nos. 2,070,281; 2,838,049; 2,898,906; 3,636,955; 3,844,272; and 3,945,117 describe a number of surgical instruments involving cutting edges or puncturing tools, their manufacture by the techniques described therein produce instruments whose wear characteristics, sharpness and blade drag present problems to surgeons and those other personnel who employ them. In this context the term blade drag refers to the force which resists the movement of the blade in a cutting procedure. The amount of tissue damage during surgery is directly dependent upon the sharpness of the blade and other factors contributing to blade drag, with the amount of extraneous tissue damage determining healing time, as well as the extent of scarring which can accompany the surgical operation.

More particularly, with respect to radial keratotomy which is a procedure in which radial cuts are made about the periphery of the cornea, it is imperative that the cuts made have smooth and flat side walls to reduce the amount of refraction and scattering caused by uneven side walls. Scalpels and other cutting instruments to date, either because of blade drag or because of a lack of sharpness, produce ragged side walls at least to the extent that after surgery, patients experience a diffuse glare looking into a strong light. The ability to provide a scalpel which can produce smooth, flat side walls during such a procedure is therefore of paramount importance.

With respect to microtome applications it will be appreciated that the microtome is an instrument which provides slices of tissue embedded in a carrier. It is of paramount importance especially in electron microscopy to produce microtome samples as thin as possible. In both electron microscopy and optical microscopy, it is of importance that the distortions in the sample due to cutting be minimized, with the distortions again being a function of blade sharpness and other factors contributing to blade drag. The minimum thickness of a substan-

tially undistorted slice is of course directly a function of blade sharpness.

With respect to scalpels and other cutting instruments made of metal, with current technology the wear characteristics are such that the blades dull significantly during use and, more particularly, during a single surgical operation. When delicate surgery is required, the ability to maintain a constant sharpness cutting edge is important to the success of the delicate surgery, with the sharper the cutting edge the better.

It will be appreciated that aluminum oxide, ruby and sapphire are all closely related materials and vary only in the concentrations of dopant metal oxides. All of these materials have the same crystal structure and as such show great similarity in physical behavior. For the purposes of this invention these materials will be referred to as aluminum oxide.

It should be pointed out that in the past, aluminum oxide blades have been utilized for surgical instruments. These blades of sapphire or ruby have in the past been made by lapping techniques which in general produce blades whose drag characteristics and sharpness, while exceeding that associated with metallic blades, nonetheless are nonoptimal for the applications described above. In addition, it will be appreciated that, in all lapping procedures, material is removed from the blade edge mechanically through abrasion, which leaves near-surface damage in the region of the bevel and edge which increases the propensity for wear and fracture.

While not used for single crystalline blades, preferential etching techniques have in the past been utilized in the semiconductor industry for the etching of aluminum oxide and silicon. Chemical polishing in the form of etching has also been utilized in material science in a wide spectrum of applications other than for the production of extremely sharp edges for cutting implements made from single crystal material.

An exception to the above is described in U.S. Pat. No. 4,124,698 in which monocrystalline ribbon produced by a so-called "EFG" process through the utilization of a die is provided with sharpened edges through the utilization of a solvent in the form of a melt of vanadium pentoxide or potassium tantalate niobate by moving a blank of the ribbon through a melt or body of solvent in a direction generally normal to the plane of the ribbon. As mentioned in this patent, the degree of edge uniformity is dependent upon the movement of the ribbon through the solvent to achieve laminar flow, with laminar flow depending upon many process variables, including the shape of the ribbon, the crucible utilized and the viscosity of the solvent. As described in this patent, unidirectional movement oftentimes results in dissolving away portions of the ribbon along only one side. It is said that it is generally preferable to reciprocate the ribbon in the solvent in order to provide for the required edge.

In this patent it is preferred that the ribbon be of a type which has the crystallographic c-axis disposed parallel to its longitudinal geometric axis, since such ribbons exhibit the best edge sharpening when subjected to the method of sharpening described in the patent. In this patent, it will be appreciated that the c-axis lies in the plane of the blade whereas, as will be described hereinafter, in the subject method the c-axis is perpendicular to the plane of the blade and no relative movement of the blade and solvent is required or even desirable.

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enhanced. This occurs regardless of the fact that the spine for the blade is initially unbeveled. For the same type of system but with an edge plane of $(1,0,1,0)$ and an etchant of sulfuric acid and phosphoric acid, it has been found that while two edges are not formed, it does produce a conventional scalpel configuration with a high degree of sharpness. Thus it has been found that, although there may be other critical edge plane constraints, the most critical constraint for simultaneous optimization of edge sharpness and production of desired blade geometry is that the blade plane be the $(0,0,0,1)$ plane in the case of aluminum oxide. More generally put, for single crystal aluminum oxide material, it is important that the crystallographic axis of the material which demonstrates three fold symmetry be approximately perpendicular to the blade plane for blades having symmetrical bevels. For single-beveled blades the set of crystallographic planes which are perpendicular to the three fold axis should be parallel to the plane which bisects the angle formed by the surfaces which are adjacent to and form the edge in question. This, coupled with the maximization of the ratio of the bevel etch rate with respect to the edge plane etch rate, achieves a maximally sharp cutting implement.

Assuming that the above constraints have been met, once the steady state has been achieved, the time in which the blade is immersed in the etchant is no longer important in determining its sharpness. Thus, in the manufacture of blades the time that the blade is left in the etchant is noncritical once this steady state has been reached.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features of the subject invention will be better understood in connection with the detail description taken in conjunction with the drawings of which:

FIG. 1 is a diagrammatic illustration of a double beveled blank illustrating the blade plane, the bevel plane and the edge plane along with bevel angle θ and an intermediate plane, I, angle Φ ;

FIG. 2 is a schematic diagram defining edge radius and edge plane for a double-beveled blank;

FIG. 3 is a diagrammatic illustration of the production of an edge with an etching process with the figure showing the evolution of the edge geometry and etch rates as a steady state etch rate and steady state edge geometry is produced;

FIG. 4 is a diagrammatic illustration of the scalpel blank illustrating a typical double edge blade geometry and defining the edge plane, the bevel plane, the point plane and the etch rates associated with those planes;

FIG. 5 is a diagrammatic illustration of a portion of a scalpel illustrating pre-etch geometry and the crystallographic orientation of the blade therefor;

FIG. 6 is a diagrammatic illustration of the blade after etching, assuming a $(1,1,2,0)$ edge plane orientation;

FIG. 6A is a diagrammatic illustration of a portion of the blade of FIG. 6 showing the point configuration;

FIG. 7 is a diagrammatic illustration of a the blade after etching assuming a $(1,0,1,0)$ edge plane orientation; and

FIG. 8 is a diagram illustrating the processing steps utilized in the formation of a cutting implement from a single crystalline substrate material.

DETAILED DESCRIPTION OF THE INVENTION

In order to reproducibly create edges using an etching technique, it is necessary that the material used be homogeneous on a scale at least as fine as the thickness of the edge that is to be produced. In addition, in order to produce the sharpest edges, using an etching technique, it is necessary to choose a material which is anisotropic with respect to the rate of removal of surface material by etching. In other words the rate of removal of surface material by etching must be dependent on which surface of the body is exposed to the etchant. If the edge is to be used for cutting purposes, then it is also desirable to fabricate such an edge on a highly wear resistant material. Single crystal Al_2O_3 was chosen as one material on which to create a very sharp edge for the following reasons. It is chemically homogeneous even on an atomic scale, and usually demonstrates a high degree of crystallographic perfection; i.e., it has low crystalline defect densities. As a single crystal it is intrinsically anisotropic. Its hardness and wear resistance is second only to diamond. It is significantly less expensive than diamond for similar size single crystals.

The choice of an etchant for the production of a sharp edge on a substrate of a specific material is complicated. Using etching techniques to produce a sharp edge which blends smoothly into a sharp point requires additional considerations beyond those to create a sharp edge. In order to simplify the development, the criteria for the production of an edge will be considered first.

The following discussion applies to the production of an edge formed by two symmetric preformed bevels as shown in FIG. 1. Here a blank 10 is shown having bevels 14 and 16 with the bevel planes as indicated. The blank is provided with a flat portion 20 which initially defines the edge plane. An intermediate plane I is defined by Φ as shown. Note that the bevel angle is illustrated by the angle θ . Note the blade plane is defined as plane 21 of the blank.

This type of edge is used on conventional razor blades or scalpels. Analogous reasoning can be used to establish the criteria for the production of edges in asymmetric cases such as an edge produced by a single bevel. During the sharpening process, the edge plane will be narrowed and the curvature of the blade in the region of the edge must be taken into account. For a curved edge region the edge plane will be defined as the tangent plane 22 to the blade which makes equal angles α, α' with the two bevel planes 24 and 26, as shown in FIG. 2.

Also shown in FIG. 2 is the parameter, r , which is defined as the average radius of curvature of the edge surface in making the transition from one bevel to the other. This parameter serves as a convenient measure of the edge sharpness and is referred to as the radius of curvature of the edge. The smaller the radius of curvature the sharper the edge.

In order to initiate this discussion it is necessary to define the terms etchant and chemical polish. An etchant is a liquid or gaseous medium which chemically removes material from the surface of an object. A chemical-polish is an etchant which has an added propensity for simultaneously smoothing the surface features of the object. The rate of etching by a chemical polish or etchant will be defined as the velocity of the material-etchant interface perpendicular to the interface.

surface regardless of the atomic mechanism by which it occurs.

In choosing an etchant to create a sharp, straight edge, on a single crystal substrate, it is highly desirable, but not necessary, to have the following properties in the etchant-material system. At least for certain crystallographic orientations the etchant should act as a chemical polish, and not preferentially attack crystalline defects such as dislocations, twins, stacking faults, etc. The etchant should have a marked propensity for maintaining planarity in the etching of macroscopically flat surface with certain crystallographic orientations. The etchant should not degrade surface or subsurface properties of the material by, for instance, changing the chemical nature of the surface region. The etchant should not leave behind surface residues. The etch rates should be anisotropic with respect to crystallographic direction.

In order to achieve maximum blade sharpness and low blade drag with chemically polished bevel surfaces, in one embodiment, a 1:1 solution of concentrated H_2SO_4 and 85% concentrated H_3PO_4 was initially chosen as the etchant for Al_2O_3 because it has all of the properties listed above. It has been found that the ratio of the acids can be varied considerably and almost identical results can be achieved.

Referring to FIG. 1, blank 10 is first formed into a general blade shape by conventional procedures such as grinding and/or lapping. In this forming process the crystallographic orientation of the material must be carefully controlled. In order to produce a sharp, straight edge by etching and to produce a final blade edge configuration which is geometrically similar to the initially formed blade it is necessary that the bevel planes which form the edge should be chemically polished in the etchant and remain planar. This produces smooth side walls which form the edge and it is required in order to maintain a straight edge. The etch rates for the bevels which form the edge are made identical in order to maintain initial blade geometry. This is true if the bevel planes are crystallographically equivalent planes with respect to etching. The etch rate for the bevel planes, V_B , are made to satisfy the following inequality with respect to the edge plane etch rate, V_E , and the bevel angle, θ , which is defined in FIG. 1.

$$V_B > V_E \frac{\sin \theta}{\cos^2 \theta}$$

If this inequality is not obtained, the edge plane will enlarge during etching and the edge will become duller, e.g., the edge radius of curvature will increase. If the inequality is obtained, the etch rate of the bevel planes is sufficiently rapid to decrease the size of the edge plane during the simultaneous etching of the bevel and edge planes.

It is desirable but not a requirement, to have the edge plane chemically polished in the etching process. For situations where both the edge plane and the bevel planes are chemically polished, the following criteria must be met in addition to the above criteria.

Let α define the crystallographic direction which is simultaneously parallel to both the bevel and edge planes. Now consider a plane, I, which is intermediate in orientation between a bevel plane and the edge plane and which is also parallel to α as shown in FIG. 1. Let Φ be defined as the angle between the edge plane and

the intermediate plane I. Let V_I be the etch velocity of plane I. Then V_I must satisfy the following criteria.

$$V_I < \frac{\left[\left(\frac{V_B}{\cos \theta} - V_E \tan \theta \right)^2 + (V_E)^2 \right]^{1/2}}{\cos \beta}$$

$$\text{where } \beta = \Phi - \tan^{-1} \left(\frac{V_E}{\frac{V_B}{\cos \theta} - V_E \tan \theta} \right)$$

If this criteria is not met the angle of the bevels, θ , will not be maintained in the region of the edge during etching. In particular the intermediate plane, I, which most greatly violates the above inequality will form new bevel planes in the neighborhood of the edge.

For the specific case of Al_2O_3 in the etchant defined above, in one embodiment, the following blade geometry and crystallographic orientation were used and all of the above criteria were met. The bevel angle θ was chosen to be 13° , consistent with the conventional blade technology. The plane of the blade was chosen to be the (0,0,0,1) plane. The edge plane was chosen to be a (1,1,2,0) plane. Thus, the bevel planes are the (1,1,2,12) and (1,1,2,12) planes. It is a finding of this invention that if the blade plane is the (0,0,0,1) plane, that all the above requirements are met utilizing the above etchant.

With this blade edge geometry and crystallographic orientation defined above, edges with a radius of curvature less than 100 Å have been produced.

If the above criteria are met then the etching process will produce a sharpening of the edge, and bevel geometry will be maintained. By sharpening it is meant that the size of the edge plane will reduce during etching. As the edge plane narrows to very small spatial dimension, the average radius of curvature of the edge region must decrease in making the transition from one bevel plane to the other. As the bevel planes approach each other, the edge can no longer be treated as planar. The decreasing radius of curvature of this region must be taken into account. In particular the region of the edge will experience an increase in the etch rate due to surface energy effects. The smaller the radius of curvature of the edge, the faster the etch rate. This is a manifestation of the Gibbs-Thompson surface energy effect. Let the etch rate for the tangent plane to the edge region which is parallel to the previous edge plane be defined as V_E' . The edge will continue to narrow until such time as a steady state condition results. A steady state condition will result when V_E' becomes sufficiently large that

$$V_E' = \frac{V_B}{\sin \theta}$$

When this velocity limit is reached, the edge no longer changes geometry, but recedes with a constant radius of curvature.

This limiting process is illustrated in FIG. 3. FIG. 3 shows a time sequence of bevel and edge profiles 30-38 during the etching process. The time increment between each profile is the same. Thus, the incremental change in bevel position is constant throughout the sequence, i.e., the perpendicular distance between bevel profiles is constant. This result obtains because of constant bevel etch velocities, V_B . As the blade plane nar-

rows in the sharpening process, the constant bevel etch velocity constraint requires that the edge etch velocity increase substantially. This geometrical result can be visualized in FIG. 3 by recognizing that the incremental distance traveled by the edge in the time sequence increases. The required increase in edge plane etch velocity can only be accommodated by a decrease in the radius of curvature of the edge region producing an increased etch rate.

The edge produced is extremely uniform in thickness because of the limiting process. Moreover, the edge thickness can be controlled by choosing θ and/or the ratio V_B/V_E . Since V_E and V_B will in general have different temperature dependencies, it is also in principle possible to control the steady state edge thickness by controlling temperature.

In order to achieve maximum sharpness, the crystallographic orientation defined above was chosen to make the ratio V_B/V_E as large as possible and still meet other requirements. V_B/V_E is approximately equal to 20 at 285° C. With a bevel angle, θ , of 13°, the steady state edge velocity, V_E' increases approximately 100 fold to 4.5 times the bevel etch rate.

The edges produced are extremely straight and uniform in thickness throughout their entire length. This is due to the fact that the edge formation is controlled by thermodynamic properties of the edge-etchant system and not by mechanical means as in other forming techniques. It is of importance to note that the process described is relatively insensitive to initial edge roughness. In fact, if small chips are broken from an edge which has already been formed by etching, a perfect edge can be reformed by further etching.

Care must be taken in removing the blades from the etchant and cooling to room temperature. The Al_2O_3 is very subject to thermal shock and thermally quenching the blades will produce mechanically weak edges which deteriorate quickly when used in cutting procedures.

FIG. 4 shows a side view of a scalpel blade 40. The schematic drawing shows that the point 42 is not well formed. As shown, point 42 is blunted by the existence of a point plane which is perpendicular to the blade plane and which makes an angle, β , with the spine plane. A configuration such as this is often encountered after the initial mechanical forming of a blade. For Al_2O_3 and one crystallographic orientation the bevel plane, edge plane, point plane, and spine plane as noted.

If the point etch rate, V_p , is too large compared to the edge etch rate V_E , and the spine etch rate, V_S , the point will blunt the cutting edge in the region near the point. In the configuration shown, the edge will not blunt in this mode if

$$V_E' + \frac{V_S}{\cos \beta} \sin(\beta - \alpha) \geq V_p \cos(\beta - \alpha)$$

If the crystallographic orientation is chosen such that the etch rate, V_B , for the bevel planes is a maximum or near maximum for the etchant-crystal system, then the steady state value of V_E' will be very large, and this mode of blunting will be prevented. The rapid motion of the edge will quickly close off the point plane.

This strategy was carried out with Al_2O_3 . In one embodiment, the edge plane was chosen as the (1,1,2,0) plane. The bevel planes (1,1,2,12) and (1,1,2,12) etch rapidly but are not, however, the most rapidly etching planes. Nevertheless the blunting mode described above

was avoided. FIG. 5 shows the pre-etch geometry of a blank 10 with an indication that the blade plane, e.g., surface 50, is the (0,0,0,1) crystallographic plane. The surface 50 is beveled at 52 as illustrated. FIGS. 6 and 6A show the geometry of the points which have been produced in Al_2O_3 with the edge plane being (1,1,2,0).

As can be seen in FIG. 6, the etching procedure produces a beveling 60 of the sides of the spine 62 of the blade 64. The beveling is symmetric because of crystal symmetry. This etching mode thus produced a double edge configuration at the blade point 66. The edge produced by the original bevels, edge 68, runs all the way to the point. The bevels 60 on the sides of spine 62 also produce an edge 70 from the point back a short distance along spine 62. This geometry has a strengthening effect on the blade point. It also enhances the plunging characteristics of the blade.

At lower etching temperatures (~240° C.) spine bevels do not chemically polish. However at higher temperatures there is some preliminary indication that the bevels will chemically polish.

The feasibility of producing scalpels with different crystallographic orientations have been examined. Referring now to FIG. 7, the blade plane was chosen as before to be the (0,0,0,1) plane. The edge plane was chosen to be the (1,0,1,0) plane and 13° bevel angles and a 30° point angle were maintained. Here the tip of the blade is shown in which the blade 80 has a bevel 82, a point 84, and spine bevels 86. Here no spine edge is produced. It is thus possible to successfully produce scalpels with this crystallographic orientation as well. However, some differences in etching behavior were noted. Although the bevel planes are in general chemically polished, minor etch pitting was seen at sites where dislocations intersected the bevel plane. The pitting was not found with the previous orientation. Additionally the point configuration changed significantly as shown in FIG. 7. The beveling of the spine sides by etching was again apparent in the FIG. 7 configuration but because of the difference in point etching, the spine bevels actually form the edge in the region of the point. At the etching temperatures used (~260° C.) the spine bevels did not chemically polish, so that a microscopically straight edge was not produced in the region of the point. Despite these drawbacks, the results of surgical testing showed no significant difference in performance between the two blade configurations.

FIG. 8 illustrates one method for producing surgical scalpel blades. In an orientation step 90, the substrate is initially cut from a large single crystal with the orientation such as that shown to the right in FIG. 8. The side of the substrate where the bevels are to be formed is then mechanically polished in a step 92 to reduce the near-surface damage due to the cutting process. The preliminary bevels are then lapped in a step 94. The scalpel blank is then cut in a step 96 along dotted lines 98 from the substrate and the sides of the blank bordering the cuts are then mechanically polished in this step to reduce near-surface damage on these surfaces and to shape a preliminary point. The blank is then annealed in step 98 at elevated temperatures to further reduce near-surface damage. The blade is finally etched in a step 100 to produce the sharpened scalpel.

Having above indicated a preferred embodiment of the present invention, it will occur to those skilled in the art that modifications and alternatives can be practiced within the spirit of the invention. It is accordingly in-

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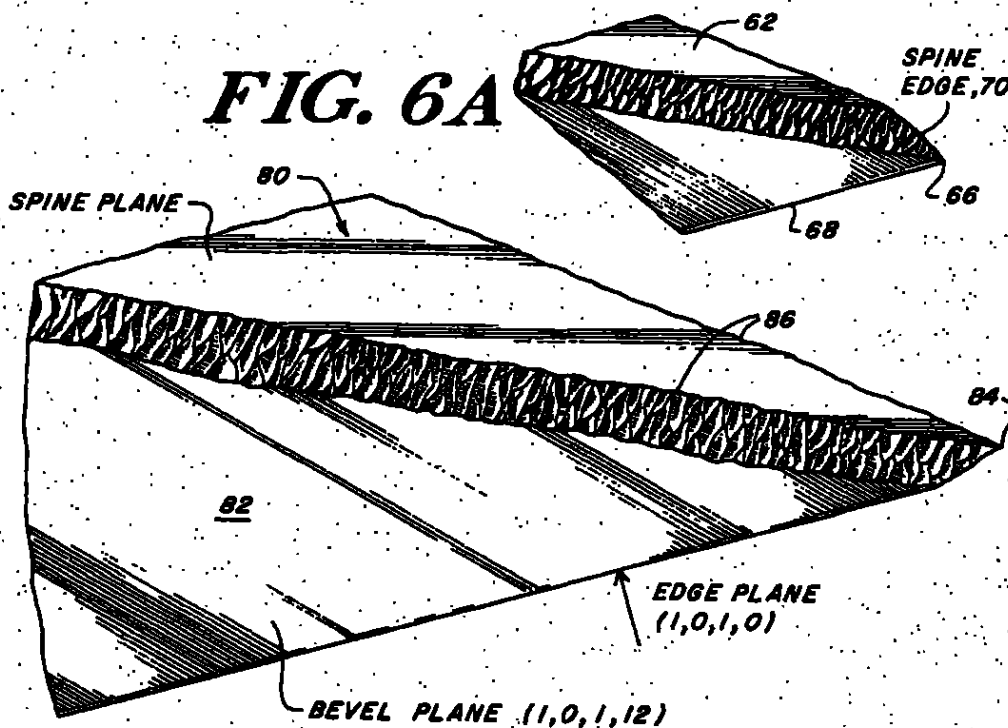
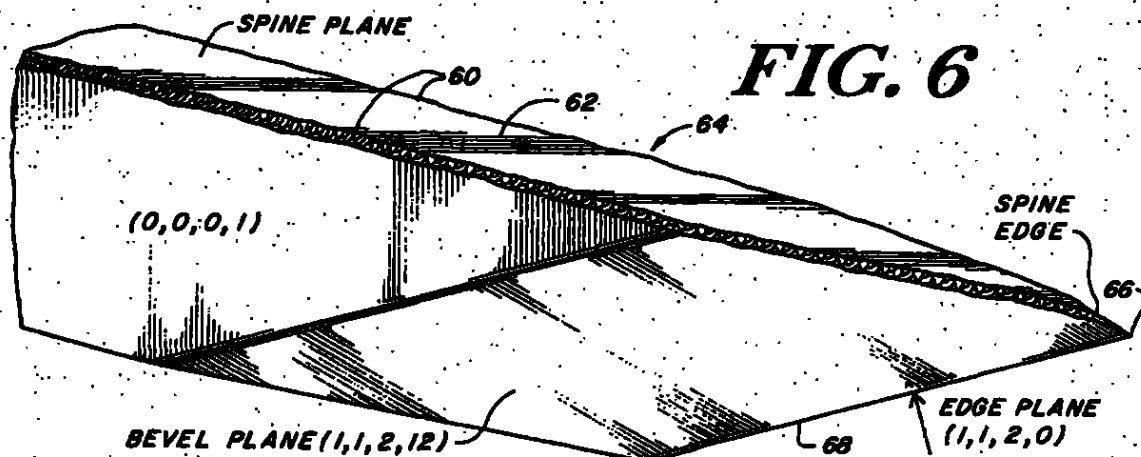
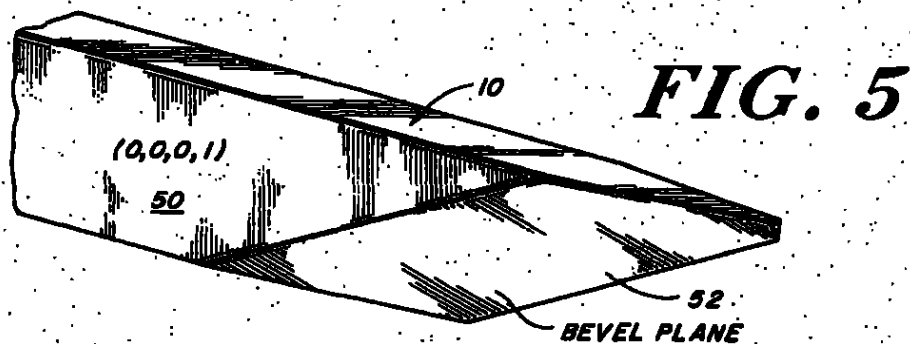


FIG. 7

tended to define the scope of the invention only as indicated in the following claims.

What is claimed is:

1. A method of fabricating a cutting instrument from single crystal material comprising the steps of:
 - providing a blank of single crystal aluminum oxide material having bevel surfaces which provide a preliminary cutting instrument edge, said blank oriented such that the (0001) plane is parallel to the planar bisector of the angle formed by the bevel surfaces of the blank which meet at the edge, the c-axis being perpendicular to said plane; and simultaneously etching and chemically polishing the blank to form the cutting instrument edge, said etchant acting as a chemical polish for the bevels forming said cutting instrument edge, said cutting instrument edge being perpendicular to said c-axis.
2. The method of claim 1 wherein the etchant used for etching the blank is a mixture of sulfuric acid and phosphoric acid.
3. The method of claim 1 wherein said preliminary edge defines an edge plane and wherein said edge plane is parallel to one of the planes of the form (1,1,2,0).

4. The method of claim 1 wherein said preliminary edge defines an edge plane and wherein said edge plane is parallel to one of the planes of the form (1,0,1,0).
5. The method of claim 1 further comprising: selecting a combination of crystallographic orientation of said preliminary edge, the crystallographic orientations of said surfaces which provide said preliminary edge, and at least one chemical etchant, such that in said etching and polishing step the surfaces which provide said preliminary edge are etched at a rate greater than the rate of etching of said preliminary edge.
6. The method of claim 5 wherein the crystallographic orientation of said preliminary edge, the crystallographic orientations of said surfaces which provide said preliminary edge, and said chemical etchant are selected such that the ratio of the rate of etching of said edge-providing surfaces to the rate of etching of said preliminary edge is a maximum.
7. The method of claim 5 wherein in the step of simultaneously etching and chemically polishing said blank, the action of said etchant on the surfaces which provide said preliminary edge produces a narrowing of said preliminary edge and ultimately forms a sharp edge having a maximum radius of curvature of 100 Å.
8. The method of claim 1 wherein said single-crystal aluminum oxide material is ruby or sapphire.

* * * * *

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[54] SAFETY RAZOR BLADE

[75] Inventor: Robert A. Trotta, Pembroke, Mass.
[73] Assignee: The Gillette Company, Boston, Mass.
[21] Appl. No.: 505,853
[22] Filed: Apr. 5, 1990

[31] Int. Cl.³ B26B 21/00; B26B 21/54
[32] U.S. Cl. 30/50; 30/346.53;
76/104.1; 76/DIG. 8
[58] Field of Search 30/346.51, 346.53, 50;
76/DIG. 8, DIG. 9, 104.1, 101.1

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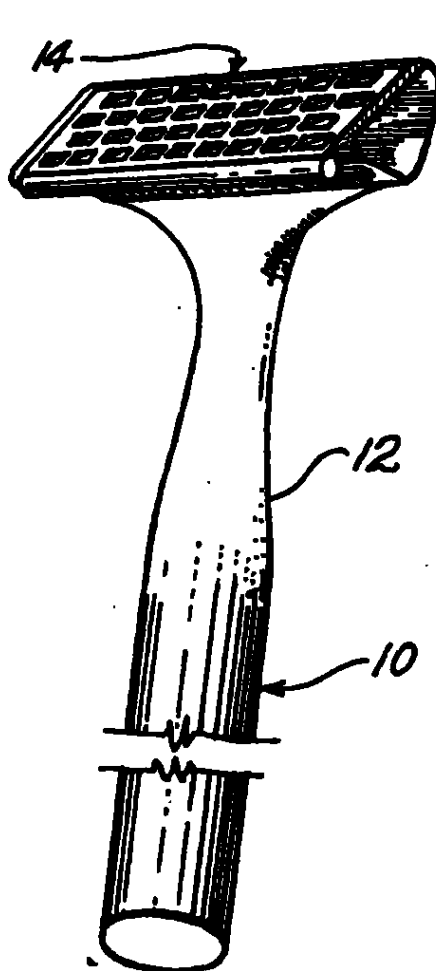
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Primary Examiner—Douglas D. Watts
Assistant Examiner—Paul M. Heyrana, Sr.
Attorney, Agent, or Firm—Owen J. McEgan; Aubrey C. Brine; John P. Morley

[57] ABSTRACT

A blade for use in a safety razor is manufactured by providing a block of green or uncured ceramic material. The block is in the form of a honeycomb structure having a plurality of substantially parallel cells formed therein and a portion is sliced and removed from the block forming at least one surface on the portion intersecting the parallel cells at an angle. The portion is cured, and the surface ground and polished to provide a plurality of cutting edges.

20 Claims, 1 Drawing Sheet



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FIG. 1

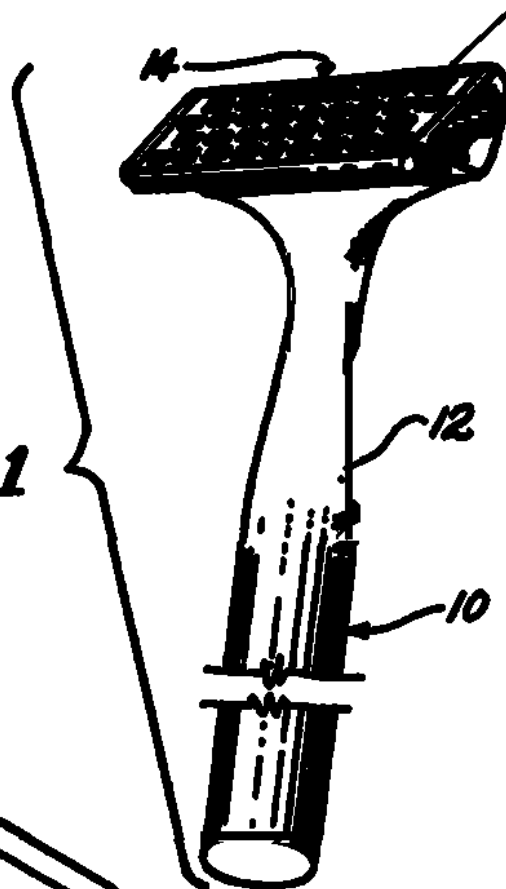


FIG. 2

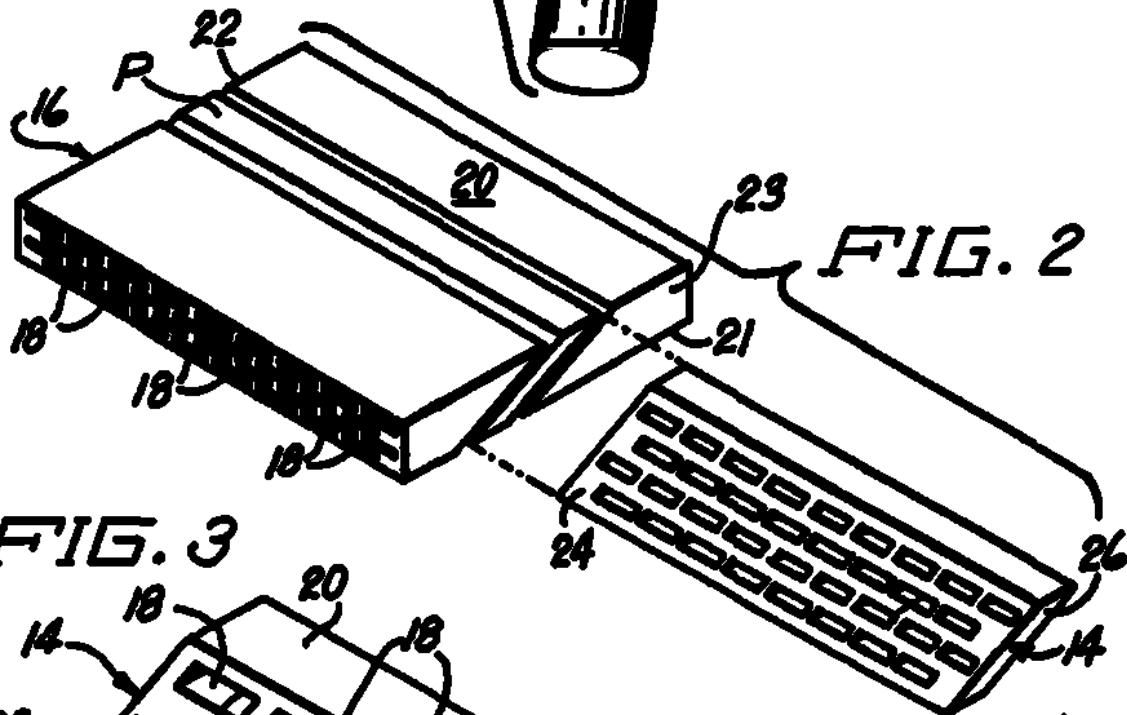


FIG. 3

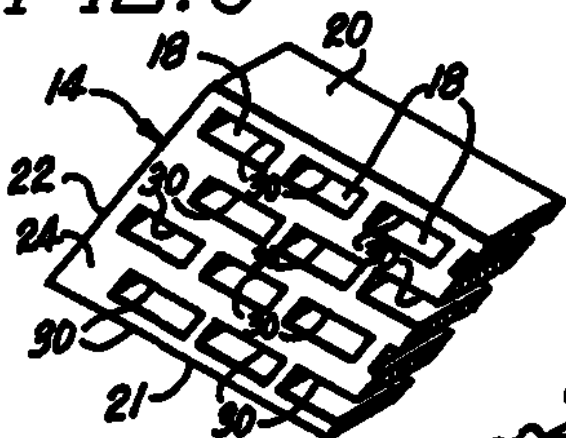


FIG. 4



SAFETY RAZOR BLADE

BACKGROUND OF THE INVENTION

The present invention relates to a blade for use in a safety razor, and more particularly to a ceramic blade of that type, and the method of manufacturing the same.

Various blade constructions and shaving units have been disclosed in the prior art wherein the blades have been shown constructed of glass or other vitreous materials to form a blade suitable for employment in a shaving implement. For example, a ceramic cutting blade is disclosed in U.S. Pat. No. 3,543,402 issued to R. M. Seager and a blade manufactured from at least two vitreous materials is disclosed in U.S. Pat. No. 3,831,466 issued to Hicks, Jr. Other blades of glass construction are disclosed in U.S. Pat. No. 3,805,387 issued to Siegmund et al and U.S. Pat. No. 4,011,071 issued to Walter P. Siegmund. It is also suggested in the prior art that a plurality of similarly shaped hollow blades may be formed into a razor unit and such devices are shown in the above cited U.S. Pat. No. 3,805,387 issued to Siegmund et al as well as U.S. Pat. No. 4,807,360 issued to Cerier et al.

While the above attempts to create a non-metallic razor blade may be successfully accomplished, it is considered that there is a need for a more simple structure having fewer steps in fabrication in order to meet the requirements for mass production of blades in those quantities achieved in razor blade manufacture. As is obvious, the employment of a plurality of separate elements which must be fused or formed in some manner to produce the final product requires handling of a plurality of materials as well as a number of assembly and treatment steps to produce the final blade structure.

It is also evident that the employment of a plurality of components combined with a complex process renders a blade of the type under consideration costly to manufacture and therefore not applicable to employment in a razor of the discardable type which is prominent in the market today.

It is therefore an object of the present invention to provide a blade for use in a safety razor having a unitary structure which is simple to manufacture and which may be produced economically.

A further object of the present invention is to provide a blade of the type under consideration which may be manufactured under mass production techniques.

Another objection of the present invention is to provide a blade for use in a safety razor which is simple to care for during the shaving process, and is easily cleaned during the shaving process.

Yet another object of the present invention is to provide a method for manufacturing a blade from a block of ceramic material which is simple to perform and adaptable to mass production techniques.

SUMMARY OF THE INVENTION

The aforementioned objects and other objectives which will become apparent as the description proceeds are accomplished by providing a method of manufacturing a razor blade which includes the step of providing a block of ceramic material in the form of a honeycomb structure having a plurality of substantially parallel cells formed therein. At least one surface is formed on the structure intersecting each of the parallel cells at an acute angle and the one surface is ground and polished to form a plurality of sharpened edges at the inter-

section of the surface with the periphery of each of the cells to thereby provide a plurality of cutting edges to be used in the shaving process.

The block of ceramic material is generally provided in the green or uncured condition and is cured by sintering the formed block prior to the step of grinding and polishing. A suitable shaving surface is generally provided by applying a coating of platinum chrome to the one surface after grinding and polishing after which a telomer coating is applied over the platinum chrome.

The material employed in forming the honeycomb structure may be any of a number of hard ceramic materials as exemplified by the group consisting of zirconia, tetragonal zirconia, partially stabilized zirconia, zirconia stabilized alumina, cordierite, mullite, boron carbide, titanium nitride, silicon nitride and aluminum oxide.

The blade thus formed comprises a block of ceramic material in the form of a honeycomb structure having a plurality of substantially parallel cells formed there-through. The blade further comprises a front surface intersecting each of the parallel cells at an acute angle thereto to form a plurality of cutting edges produced by the intersection of the front surface with each of the parallel cells. The blade may have a top surface and a bottom surface, each extending rearwardly in a direction parallel with the cells of the honeycomb structure, and the parallel cells may be rectangular in cross-section. The acute angle between the front surface and the plurality of parallel cells is generally in the area of 20° to 25°.

BRIEF DESCRIPTION OF THE DRAWING

The foregoing and other features of the invention will be more particularly described in connection with the preferred embodiment, and with reference to the accompanying drawing, wherein:

FIG. 1 is an elevational perspective view showing a shaving instrument having a blade constructed in accordance with the teachings of the present invention;

FIG. 2 is an exploded view showing the blade of FIG. 1 depicting the various steps of manufacture of the blade;

FIG. 3 is a partial elevational perspective view showing details of the blade of FIGS. 1 and 2 taken on an enlarged scale for clarity; and

FIG. 4 is an elevational sectional view showing a cross-section taken through the blade of FIGS. 1 through 3 to disclose further details of the blade structure.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, and in particular to FIG. 1, there is shown a safety razor 10 comprising a handle 12 with a blade 14 mounted thereon. It should be understood that the razor 10 may be of the disposable type wherein the blade 14 is permanently affixed to the handle 12 or of the reusable type, wherein the blade 14 is removable, and may be attached by any of a plurality of means well known in the art.

Referring now to FIG. 2, the blade is generally manufactured by providing a block 16 of ceramic material in the form of a honeycomb structure having a plurality of substantially parallel cells 18 formed therein. The block 16 may be of a ceramic material such as zirconia, tetragonal zirconia, aluminum oxide, etc. as referred to here-

inbefore, which are capable of being extruded into the shape shown in FIG. 2 while in the green or uncured condition. The block 16, as shown in FIG. 2, is in the form of a rectangle having a top surface 20, bottom surface 21 and side surfaces 22 and 23.

As best shown in FIG. 2, the blade 14 is formed from the block 16 while in the green or uncured state by slicing a portion P from the block at an acute angle A with the top surface 20, the bottom surface 21, and the upper and lower walls of the cells 18 which are parallel to the top and bottom surfaces of the block.

Referring now to FIG. 4, the angle A which is designated as the angle at which the blade 14 is cut from the block 16 is generally in the area of 20° to 25°. By slicing the block 16 at the acute angle A, a front surface 24 and a rear surface 26 are formed which are parallel and which intersect each of the parallel cells 18 at an angle equal to the angle A.

After the blade 14 is formed as shown in FIGS. 2 and 4, it is subjected to an elevated temperature for a period of time sufficient to properly cure or harden the particular ceramic material, which temperature and time should be known to those familiar with the particular ceramic being employed.

With the blade 14 in the hardened condition, it is subjected to a grinding and polishing process at the surface 24 (or at the surfaces 24 and 26 if both sides of the blade 14 are to be employed) such as to form a plurality of sharpened edges 30 at the intersection of the surface 24 with each of the cells 18, and with the surface 21. The blade 14 is now subjected to a coating of platinum chrome over which a telomer coating is applied to produce a blade having a plurality of cutting edges 30 which are adequately sharp and have the wearability necessary to provide a durable shaving instrument.

From the above, it should be observed that the manufacture of the blade 14 lends itself to mass production in that a block 16 of green extruded ceramic material may be sliced into a plurality of portions P which in turn are subjected to general production techniques, such as subsequent grinding, polishing and plating procedures. Also, as alluded to above, while the razor 10 depicted in FIG. 1 is shown to be a discardable shaving instrument having the blade 14 cemented or otherwise affixed to the handle 12, the blade may be incorporated into a similar handle which is manufactured to be employed over a period of time with discardable blades. In the employment of a blade 14 with a razor wherein the blade is to be inserted into the razor handle, both the surfaces 24 and 26 would be treated as set forth above and upon the requirement of a new blade, the blade would be inverted and the surface 26 would be employed in the shaving process in a similar manner as that of the surface 24.

It should therefore be evident that the present invention provides a safety razor blade which is simple to manufacture, lends itself to mass production techniques and is therefore inexpensive and readily adapted to the manufacture of a discardable razor.

I claim:

1. A method of manufacturing a razor blade which includes the steps of:

providing a unitary block of ceramic material in the form of a honeycomb structure having a plurality of substantially parallel cells formed therein;

forming at least one surface on the structure intersecting each of the parallel cells at an acute angle; and

grinding and polishing the one surface to form a plurality of sharpened edges at the intersection of the one surface with the periphery of each of the cells to thereby provide a plurality of cutting edges to be employed in the shaving process.

2. A method as set forth in claim 1 wherein each of the cells is rectangular in shape.

3. A method as set forth in claim 2 wherein the block has an upper surface and a lower surface parallel to the plurality of cells.

4. A method as set forth in claim 3 wherein said block of ceramic material is provided in the green or uncured condition and further includes the step of curing the block by sintering the formed block prior to the step of grinding.

5. A method as set forth in claim 4 wherein the acute angle formed is in the area of 20° to 25°.

6. A method as set forth in claim 5 which includes the step of applying a coating of platinum chrome to the one surface after grinding and the further step of applying a telomer coating over said platinum chrome to provide a finish to said cutting edges.

7. A method as set forth in claim 6 wherein the ceramic material is one taken from the group consisting of zirconia, tetragonal zirconia, partially stabilized zirconia, zirconia stabilized alumina, cordierite, mullite, boron carbide, titanium carbide, titanium nitride, silicon carbide, silicon nitride and aluminum oxide.

8. A method as set forth in claim 1 wherein the block has an upper surface and a lower surface parallel to the plurality of cells.

9. A method as set forth in claim 1 wherein said block of ceramic material is provided in the green or uncured condition and further includes the step of curing the block by sintering the formed block prior to the step of grinding and polishing.

10. A method as set forth in claim 1 wherein the acute angle formed is in the area of 20° to 25°.

11. A method of as set forth in claim 1 which includes the step of applying a coating of platinum chrome to the one surface after grinding and polishing, and the further step of applying a telomer coating over said platinum chrome to provide a finish to said cutting edges.

12. A method as set forth in claim 1 wherein the ceramic material is one taken from the group consisting of zirconia, tetragonal zirconia, partially stabilized zirconia, zirconia stabilized alumina, cordierite, mullite, boron carbide, titanium carbide, titanium nitride, silicon carbide, silicon nitride and aluminum oxide.

13. A blade for use in a safety razor comprising: a unitary block of ceramic material in the form of a honeycomb structure having a plurality of substantially parallel cells formed therein, said block comprising a front surface intersecting each of said parallel cells at an acute angle thereto; and a plurality of cutting edges formed by the intersection of said front surface with each of said parallel cells.

14. A blade as set forth in claim 13 wherein said block further includes a top surface and a bottom surface, each extending rearwardly in a direction parallel with said cells of said honeycomb structure.

15. A blade as set forth in claim 14 wherein said parallel cells are rectangular in cross-section.

16. A blade as set forth in claim 15 wherein said acute angle between said front surface and said plurality of parallel cells is in the area of 20° to 25°.

17. A blade as set forth in claim 16 which further includes a rear surface intersecting each of said parallel

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cells and wherein said front surface and said rear surface are substantially parallel.

18. A blade as set forth in claim 13 wherein said parallel cells are rectangular in cross-section.

19. A blade as set forth in claim 13 wherein said acute

angle between said front surface and said plurality of parallel cells is in the area of 20° to 25°.

20. A blade as set forth in claim 13 which further includes a rear surface intersecting each of said parallel cells and wherein said front surface and said rear surface are substantially parallel.

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SAFETY RAZOR

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 Fecha de publicación: 2000-11-02
 Inventor: WHITE ROBERT (GB); SIMMS GRAHAM JOHN (GB); POWELL KEVIN L (GB)
 Solicitante: GILLETTE CO (US); WHITE ROBERT (GB); SIMMS GRAHAM JOHN (GB); POWELL KEVIN L (GB)
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 DE60021367T (T2)
 CN1222396C (C)
 AU779862B (B2)

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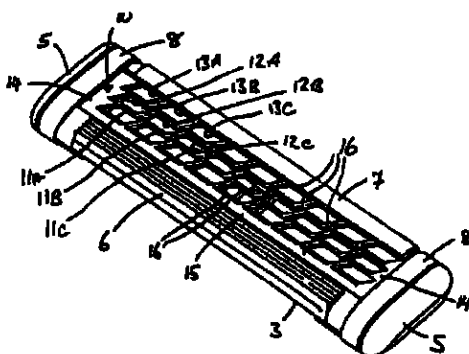
Documentos citados:

US5018274
 US5048191
 US4534827

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Resumen de WO0064644

The invention relates to shaving and is concerned with a blade formed from a single crystal ceramic material. The blade presents a sharp cutting edge and support elements are provided for mounting and positioning the blade (cutting element) in a blade unit. A guard element is disposed forwardly of the cutting edge and extends parallel thereto. A plurality of parallel cutting elements may be provided. The invention also concerns a method of making the cutting element.



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