Patent Basics

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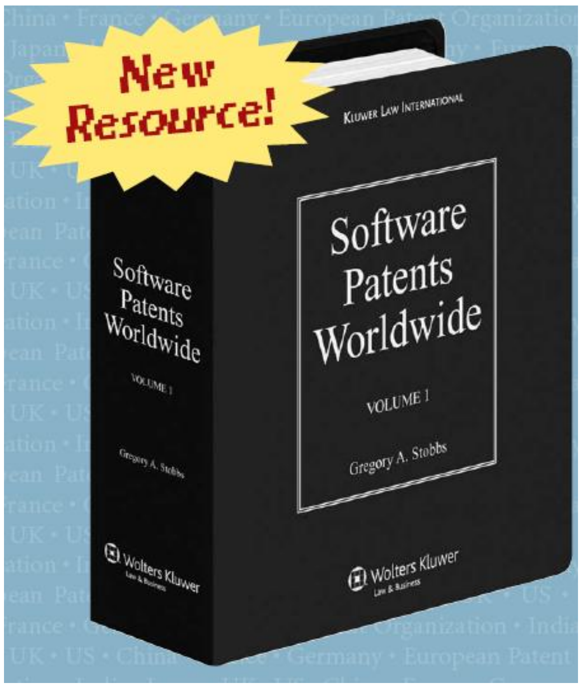
Introductions

- Name: Hasit Seth
- .edu = BSc (Computer Sci.), LL.B., LL.M (Mumbai Uni., Gold Medal), LL.M (Franklin Pierce, USA)
- US Patent Office Exam
- Bar – New York, Maharashtra & Goa

Disclaimers

- I am here in my personal capacity.
- Views expressed are solely personal and may not be those of my present or past employers.
- This is not legal advice and am not soliciting any legal work.

Contributing Author



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PATENTS

An Introduction

Property

- A bundle of rights
- Two Kinds:
  - Real Property – e.g., Land, Buildings, etc.
  - Intellectual Property – Trademarks, Patents, Copyrights
- IP – Another Term is Industrial Property

Species of IP

- Patents
- Trademark
- Copyright
- Trade Secret
- Designs

Criteria for Patentability

- Useful
- Novelty
  - Must not be published or known anywhere in the world
- Non-obvious
  - Obvious combination or variation of a known thing or process

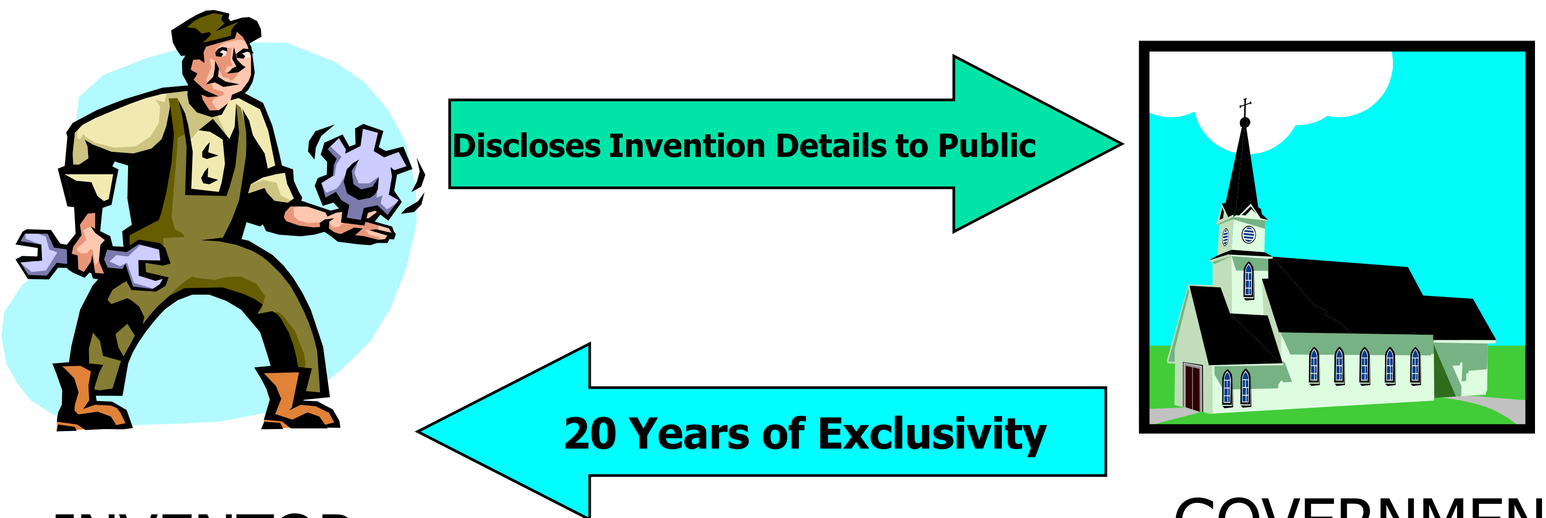
Subject-Matter

- Machines / Systems
- Processes
- Articles of Manufacture
- Chemicals/Substances
- Biotechnology

Term

- 20 Years from date of filing
- Nobody other than patent owner can
  - Make
  - Use
  - Sell
  - Offer for Sale, the invention…

Patent - A Govt.-Inventor Barter

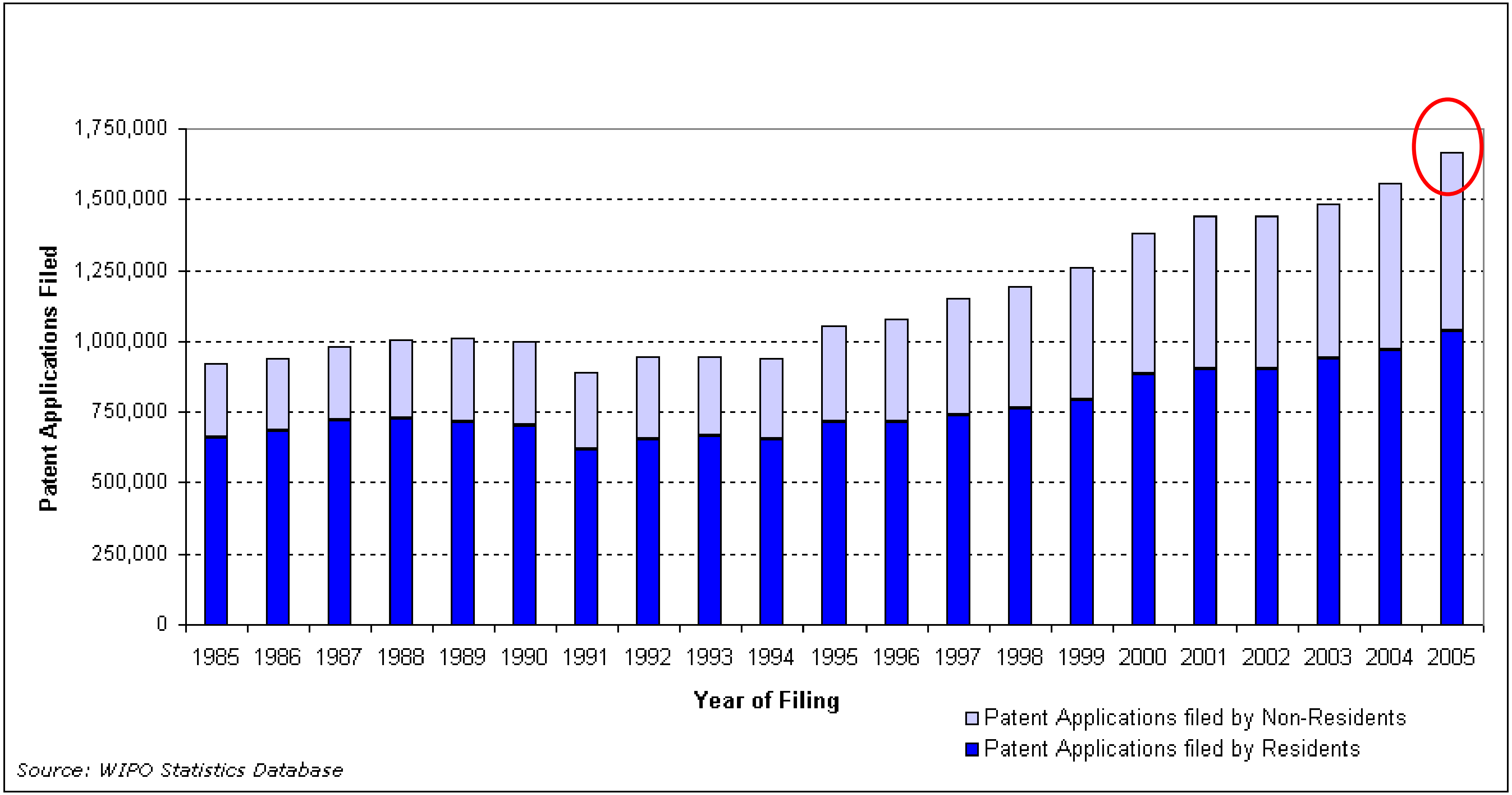


INVENTOR

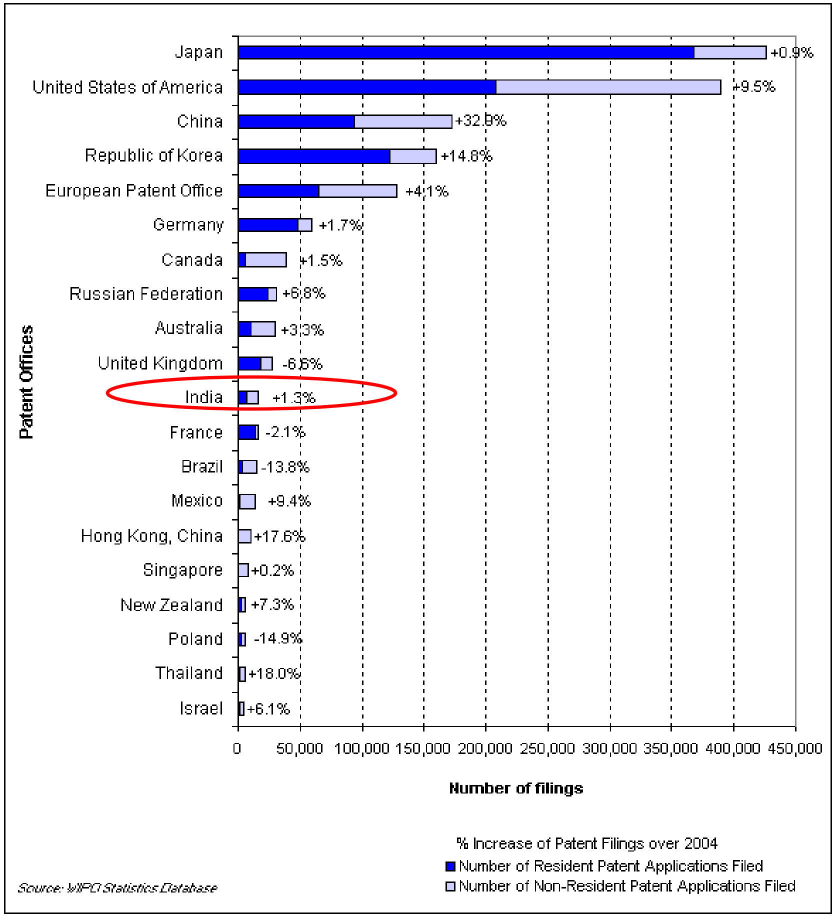
GOVERNMENT

Term of a Patent – 20 years from the date of filing

World-Wide Patent Filings



India – Patent Filings



Criteria for Patentability

- Useful
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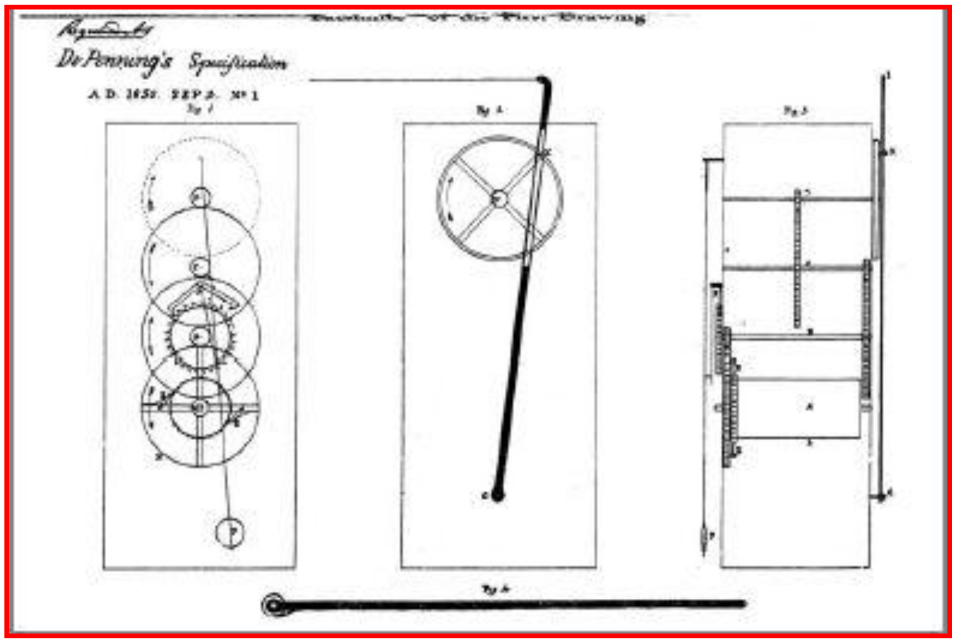
National Scope

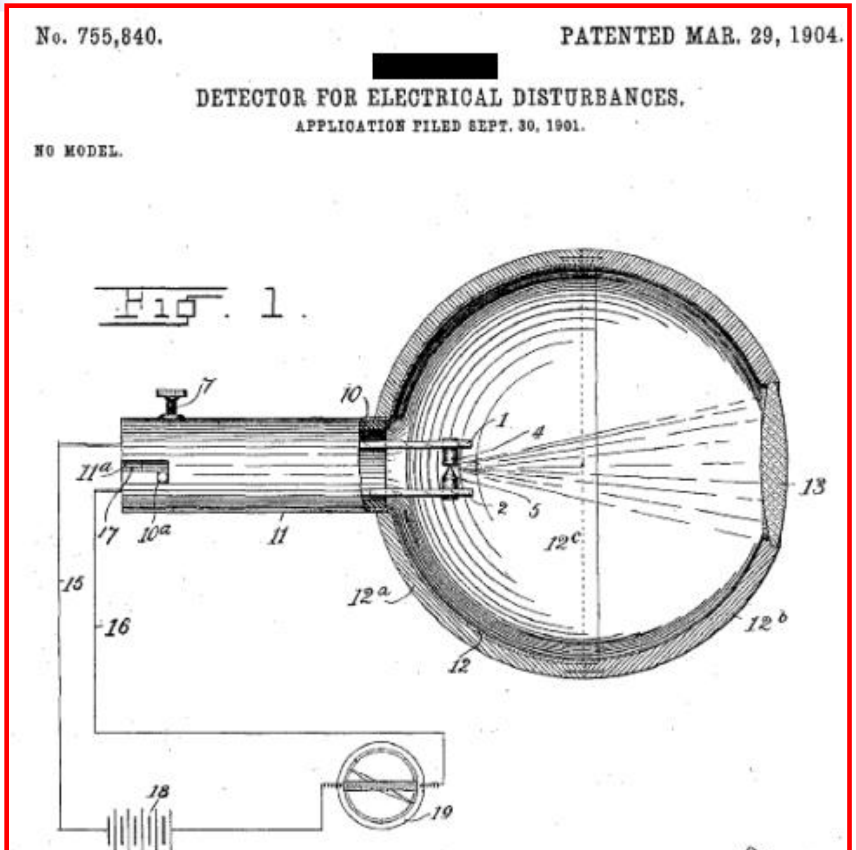
- No world patent; need to get patent in each country
- Patent Cooperation Treaty (PCT) a "postal system" – 18 months window
- Paris Convention – 1 year window

First Indian Patent – 150 years



- Issued to Alfred De Penning in 1856
- "An efficient Punkah Pulling Machine"

First US Patent to An Indian



- Jagdish Chandra Bose!
- "Detector For Electrical Disturbances"

US Patent Classification

- Class 977
  - 700 – Nanostructures
  - 839 – Mathematical Algorithms
  - 840 – Manufacture, Treatment, Detection of Nanostructures
  - 902 – Specified Use of Nanostructures
  - 963 - Miscellaneous

A Patent Example

A Nanostructure (Class 977/700)
Patent Issued by USPTO

Patent Parts

- Coversheet – Bibliographic Data
- Drawings
- Specification (Technical Description)
- Claims

US Patent – 6,464,806

(12) **United States Patent**
Naeem et al.

Inventors

(10) **Patent No.:** **US 6,464,806 B1**
(45) **Date of Patent:** **Oct. 15, 2002**

(54) **METHOD OF FORMING EXTRUDED STRUCTURES FROM POLYCRYSTALLINE MATERIALS AND DEVICES FORMED THEREBY**

(75) Inventors: **Munir D. Naeem**, Poughkeesie; **Lawrence A. Clevenger**, Lagrangeville, both of NY (US)

Assignee

(73) Assignee: **International Business Machines Corporation**, Armonk, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/543,377**

(22) Filed: **Apr. 5, 2000**

(51) **Int. Cl.**[7] **C22F 1/04**; C22F 1/08; C22F 1/16

(52) **U.S. Cl.** **148/559**; 148/656; 148/679; 148/689

(58) **Field of Search** 148/559, 656, 148/679, 688, 689

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,921,549 A * 5/1990 Austin 148/656

* cited by examiner

Primary Examiner—George Wyszomierski
(74) *Attorney, Agent, or Firm*—Casey P. August; Gary M. Hartman; Domenica N. S. Hartman

(57) **ABSTRACT**

A method of forming extruded structures from a polycrystalline material and structures formed thereby. The method generally entails forming a structure that comprises a polycrystalline material constrained by a second material in all but one direction, with the polycrystalline material having a patterned surface that is normal to the one direction. The polycrystalline material is then selectively heated, during which the second material restricts thermal expansion of the polycrystalline material in all but the one direction normal to the surface of the polycrystalline material. As a result, stresses are induced in the polycrystalline material that cause grain growth from the surface of the polycrystalline material in the one direction. The growth of an individual grain produces an extruded structure that projects above the surface of the polycrystalline material. When appropriately configured, nano-scale structures formed in accordance with this invention can be an operative component of a wide variety of devices, including digital recording media.

16 Claims, 1 Drawing Sheet

Abstract

(57) **ABSTRACT**

A method of forming extruded structures from a polycrystalline material and structures formed thereby. The method generally entails forming a structure that comprises a polycrystalline material constrained by a second material in all but one direction, with the polycrystalline material having a patterned surface that is normal to the one direction. The polycrystalline material is then selectively heated, during which the second material restricts thermal expansion of the polycrystalline material in all but the one direction normal to the surface of the polycrystalline material. As a result, stresses are induced in the polycrystalline material that cause grain growth from the surface of the polycrystalline material in the one direction. The growth of an individual grain produces an extruded structure that projects above the surface of the polycrystalline material. When appropriately configured, nano-scale structures formed in accordance with this invention can be an operative component of a wide variety of devices, including digital recording media.

Drawings

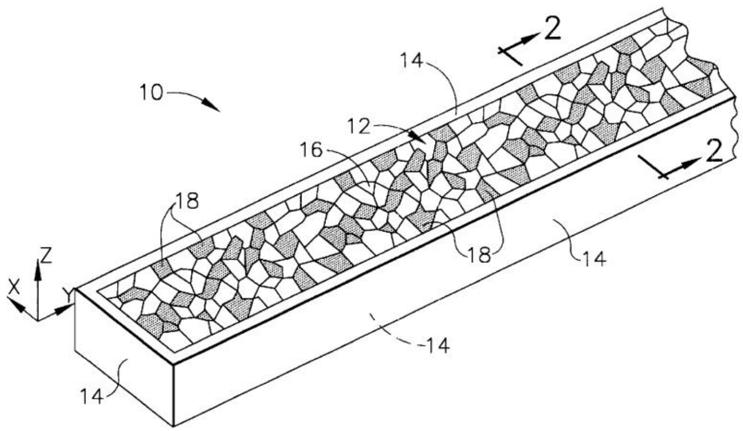


FIG. 1

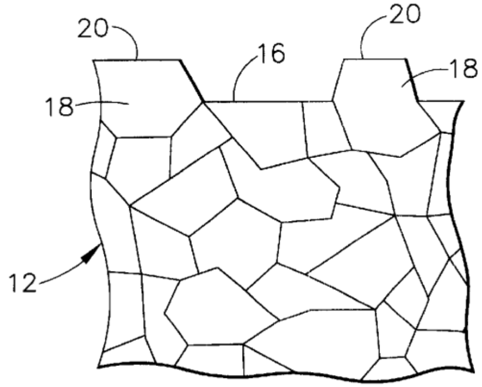


FIG. 2

Technical Description

METHOD OF FORMING EXTRUDED STRUCTURES FROM POLYCRYSTALLINE MATERIALS AND DEVICES FORMED THEREBY

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to the fabrication of microscale structures, such as structures and devices for microelectronics applications. More particularly, this invention relates to a method of forming extruded structures by initiating selective grain growth in polycrystalline materials, and devices with such structures for use in microelectronics applications.

2. Description of the Prior Art

In the past, conventional lithographic techniques have been used to produce various structural features, such as metal pads and lines for microelectronic applications. While lithographic techniques are widely and successfully used in the art, nano-scale features (i.e., operative structures and components that have a controlled dimension of less than ten nanometers) are difficult to form by conventional lithography. In view of the demand for greater miniaturization of microcircuits and their components, it would be desirable if a method were available that enabled the patterning of metallization to form nano-scale features. In addition to metal pads for microelectronic applications, a wide variety of electronic components and devices could benefit or utilize nano-scale features, including digital recording media.

SUMMARY OF THE INVENTION

The present invention provides a method of forming extruded structures from a polycrystalline material and structures formed thereby. A key aspect of the invention is the determination of the mechanism by which selective grain growth can be induced and controlled in a polycrystalline material that is constrained in all but one direction. This mechanism is believed to involve the growth of grains that have been formed by patterning and/or appropriate deposition techniques to have fewer than six grain boundaries, six grain boundaries being the most thermodynamically stable grain structure. If sufficiently heated, those grains located at a patterned surface of the polycrystalline material and having fewer than six boundaries will undergo grain growth in a direction normal to the patterned surface. If constrained during heating, as is the case if all but the patterned surface of the polycrystalline material contacts and is contained by a second material with a lower coefficient of thermal expansion (CTE), compressive stresses induced by the second material will cause this grain growth to be predominantly outward and normal to the patterned surface of the polycrystalline material.

In view of the above, the method of this invention generally entails forming a structure that comprises a polycrystalline material constrained by a constraining material in all but one direction, with the polycrystalline material having a surface that is normal to the one direction. The polycrystalline material is then selectively heated, during which the constraining material restricts thermal expansion of the polycrystalline material in all but the one direction normal to the surface of the polycrystalline material. As a result, stresses are induced in the polycrystalline material that lead to grain growth from the surface of the polycrystalline material in the one direction. The growth of an individual grain produces an extruded structure that projects above the surface of the polycrystalline material. Sufficient

grain growth can occur to produce extruded structures which are, based on an average grain size of, for example, about four μm, nano-scale structures on the surface of the polycrystalline material. (As defined herein, nano-scale designates a structure with at least one dimension that is less than ten nanometers.) When appropriately configured, nano-scale structures formed in accordance with this invention can be an operative component of a wide variety of devices, including digital recording media.

Other objects and advantages of this invention will be better appreciated from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** represents a perspective view of a multimaterial structure that defines digital recording media in accordance with an embodiment of the present invention.

FIG. **2** represents a fragmentary cross-sectional view of the multimaterial structure of FIG. **1**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention is directed to a process for forming nano-scale structures or components from multimaterial structures that include a polycrystalline material constrained by a second material. For illustrative purposes, the invention will be described in terms of a process for forming a multimaterial structure that defines digital recording media **10** shown in FIG. **1**, with a polycrystalline material **12** being surrounded and contained by a constraining material **14** at all but one surface **16** of the polycrystalline material **12**. From the following discussion, those skilled in the art will appreciate that a wide variety of materials and material combinations can be employed for the polycrystalline and constraining materials **12** and **14** of the multimaterial structure, including dielectric, conductive and semiconductive materials. As will also become apparent, the basic material requirements for a multimaterial structure suitable for use with the teachings of this invention are that a first material has a polycrystalline grain structure, and that at least one other material contacting the first material has a coefficient of thermal expansion (CTE) that is sufficiently lower than the first material such that, when the multimaterial structure is sufficiently heated, stresses are induced within the polycrystalline material to initiate grain growth from an unconstrained surface of the polycrystalline material.

The digital recording media **10** is shown in FIG. **1** as having a rectilinear shape, though other and nonrectilinear shapes are possible. As is known in the art, polycrystalline aluminum-copper, tungsten and copper alloys are widely used to form circuit interconnect metallizations, and could be employed as the polycrystalline material **12** for the recording media **10**. However, the invention is generally applicable to any polycrystalline material, including metals, metal alloys, and semiconductor materials. For use with a polycrystalline material **12** used as circuit metallization, suitable materials for the constraining material **14** include conventional diffusion barrier materials used in circuit metallizations, such as titanium, titanium nitride and combinations of both. Other suitable materials for the constraining material **14** include oxides, nitrides, metals and metal alloys, semiconductor materials, dielectrics, as well as other materials that will provide a sufficient CTE mismatch. In contrast to the polycrystalline material **12**, the constraining material **14** can have an amorphous, polycrystalline or single crystal microstructure. The dimensions of the recording

Claims

What is claimed is:

1. A method of forming nano-scale extruded structures from a polycrystalline material, the method comprising the steps of:

forming a structure comprising a polycrystalline material constrained by a constraining material in all directions but one direction, the polycrystalline material having a surface that is normal to the one direction; and then

selectively heating the polycrystalline material during which the constraining material restricts thermal expansion of the polycrystalline material in all directions but the one direction normal to the surface of the polycrystalline material, such that stresses are induced in the polycrystalline material that cause grain growth from the surface of the polycrystalline material in the one direction, the grain growth producing at least one nano-scale extruded structure projecting above the surface of the polycrystalline material.

Questions?