Epitaxial Printing

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Field

Superconductor manufacturing, High temperature Superconducting Materials, High-flux Magnets, Conducting Tapes

Technology

Electrical Engineering & Communications
Materials Science
Nanotechnology

SUMMARY

In high-temperature superconducting materials, conducting tapes that can carry large electrical currents for power or high-flux magnetic applications have not had a significant commercial impact because of the difficulty in fabricating the tapes. The grain boundaries in the superconducting material must be highly ordered as the current will rapidly drop if the grains alignment is off by as little as five degrees. We are developing a device and process for making single crystal films, for example of nickel, copper, silver, zinc, etc., by epitaxial deposition. Because such films are a single crystal, there is no current loss from grain misalignment. We have a pending patent on the device and process and seek a partner for further development and/or licensing.

TECHNOLOGY

Superconductors can carry high current without loss of power due to resistance being reduced to zero below a critical temperature. Accordingly, research has been conducted to employ high temperature superconductors in applications such as electro-magnetics and power transmission lines. In high temperature superconducting materials, conducting tapes that can carry large electrical currents for power or high-flux magnet applications have not had a significant commercial impact because of the difficulty in fabricating these conducting tapes. One of these difficulties is that grain boundaries in the superconducting material reduce the superconducting properties so that the films must consist of highly oriented grains. Although some grain misorientation is acceptable, the critical current in the superconductor drops off quickly if the spread in grain alignment becomes too large, such as on the order of five degrees or more.

Known high temperature superconducting tapes include bismuth-based and yttrium-based high temperature superconducting materials. The yttrium based tapes are more difficult to fabricate than the bismuth based tapes, but have the advantage of being desirable for use in a high magnetic field. However, yttrium-based tapes (such as YBCO) generally have poor mechanical proprieties and thus must be manufactured in a way to improve their properties.

One known method of manufacturing YBCO superconductor tapes is to form a YBCO film in a tape substrate. Multilayers of high temperature superconducting thin films of the YBCO family are deposited by sputtering or electrodeposition onto tapes of a highly oriented substrate. The substrate is typically a nickel or nickel alloy that has been oriented by a rolling and annealing process known as RaBITS. Although this process is useful, it often results in a textured substrate having a spread of grain orientation on the order of about seven degrees. As mentioned above, although some grain misorientation is acceptable, the critical current in the superconductor drops off quickly if the spread in grain alignment becomes too large.

Single crystal materials are generally known to have a minute to non-existent degree of grain misorientation because of the lack of grain boundaries in these materials. Progress has not been made in the development of single crystal continuous films by epitaxial deposition or such tape substrates of a single crystal continuous film type that can be used for applications such as high temperature superconducting materials. One of the reasons that epitaxial deposition of single crystal materials has not proved commercially viable is that it is costly to produce single crystal materials and it would thus be cost prohibitive to form a large continuous film of epitaxially deposited layers of a single crystal material. In addition, there are various inherent chemical difficulties in preparing single crystal materials.

Accordingly, there exists a need for continuous films of single crystal materials made by epitaxial deposition. There is a further need for such elongated materials that may be employed as high temperature superconducting tape substrates to enhance the current carrying capabilities of high temperature superconducting materials. The present invention addresses these needs and others.

This invention is a method for making a continuous film of a single crystal material by epitaxial deposition. This method comprises providing a single crystal template ribbonformed as a continuous loop. The method further comprises epitaxially depositing a sacrificial layer on the single crystal template ribbon by passing the single crystal template ribbon through a first processing chamber. The method then provides for passing the single crystal template ribbon with the sacrificial layer epitaxially deposited thereon through a second processing chamber, wherein a final layer comprising a single crystal material is epitaxially deposited thereon. The single crystal template ribbon with the sacrificial layer and the final layer epitaxially deposited thereon then passes thorough a third processing chamber, removing the sacrificial layer and thus detaching the final layer, which is the continuous film of a single crystal material. Additionally, the invention discloses an apparatus for making the above-described continuous film.

Another aspect of the invention provides a high temperature superconducting, semiconducting, or magnetic material comprising a continuous film of single crystal material. Further, this invention describes flat panel displays, solar cells, space applications, disk drives, read/writeheads and magnetic medial that may contain at least one high temperature superconducting material, semiconductor material or other suitable magnetic material and comprise a continuous film of a single crystal material made by epitaxial deposition.

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