Fabrication of 3-D Shaped Micro Body Structures of Diamond by Use of Focused Ion Beam

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Diamond is believed to be a suitable candidate material for micro- and nanotechnology due to its extreme hardness. However, this very property of diamond also makes its processing very difficult. More specifically, the processing of diamond by grinding with a fine powder of diamond itself is possible if the grinding shape is a planar one, but the processing of diamond into a 3-D shape by grinding is very difficult. Furthermore, in the case of diamond processing by means of ion milling, the shape is limited to a 2.5-D one and the processing speed is very low as well. The use of a focused ion beam (FIB) device could be an alternative means for processing diamond. It has been generally used as a means for preparing specimen materials for electron microscopy by sectional cutting along a certain area of the material or slicing the material into very thin flakes ranging from 100 nm to 50 nm in thickness. Although FIB device technology has been advancing in that the devices can now deal with nanometer sizes due to the very fine diameter of the ion beam, generally speaking, it is not very suitable for precision processing of 3-D shapes. Accordingly, the purpose of this paper is to introduce a FIB device which has been designed to enable the precision processing of diamond into 3-D body shapes. This has been made possible by the introduction of various additional features of the device for precision 3-D processing of any kind of specimen including even the hardest material, diamond. The features of the device include: a U-centric mechanism whereby we can retain the focused point on the specimen even when the specimen is inclined; processing capability of any configuration on a plane; processing using bit map data; controllability of irradiation period of each single beam. These combined features render the device optimally suitable for use as a tool for fabrication, e.g., for micromachines of any 3-D shape fabricated of any material including diamond. In this work, we introduce several complex demonstrations of diamond single crystal and very thick DLC having a 3-D configuration, which are made possible for the first time by the use of this sophisticated FIB device.

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