

A New Development: Powder Metallurgy with Glasses and the Resulting New Atomic Structures

Herbert Gleiter

Institute of Nanotechnology, Research Center Karlsruhe, 76021 Karlsruhe, Germany

Abstract

Since the discovery of metals, about 7000 years ago, one way to generate new crystalline materials was to introduce lattice defects e.g. grain boundaries into crystals. However, this approach does not allow to change the atomic structure of an entire crystal e.g. Cu retains its fcc structure with and without lattice defects. As the properties of solids depend on their atomic structure, the way to materials with novel properties would be open if one could generate solids, the entire atomic structure of which could be tuned by introducing defects. In order to do so, it is proposed to introduce defects into glassy solids e.g. in the form of glass/glass interfaces. This may be achieved, for example, by sintering glassy regions together or by introducing shear bands into glassy materials by plastic deformation. If the spacing between adjacent glass/glass interfaces is a few nanometers, the resulting solid is called a nano-glass. During annealing, the free volume – initially localized in the glass/glass interfaces – spreads into the adjacent glassy regions and, thus, modifies the atomic structure of the entire glassy solid. This modification may be controlled by varying the density of the glass/glass interfaces as well as by controlling the spreading process. Nano-glasses seem to open a way to generate a wide variety of solids with new atomic structures and yet unknown properties.