E-MRS FALL MEETING 2007

Acta Materialia Gold Medal Workshop

Introduction

The Board of Governors of Acta Materialia took the decision to award the 2007 Acta Materialia Gold Medal to Prof. Herbert Gleiter. Traditionally, the recipient of the medal has the right to decide where the award ceremony, which is combined with an Award Lecture, is to be held. Prof. Herbert Gleiter suggested that the ceremony should take place in Warsaw. When this became known to the organisers of the E-MRS Fall Meeting, they reacted quickly and invited Prof. Gleiter to make his Award Lecture as a Plenary Session Presentation at the Fall Meeting. The Fall Meeting organisers also considered that the occasion provided an opportunity to highlight the frontiers of research in nanotechnology, and therefore this special Acta Materialia Gold Medal Workshop was organised as one of the events at the Fall Meeting. The scope of the workshop, Perspectives of Nanoscience and Nanotechnology, focussed on the presentation of the current status of the science and technology in various fields, examples of industrial and commercial applications and other information that could facilitate decisions and future directions of research.

On being awarded the Acta Materialia Gold Medal Professor Gleiter delivered his Plenary Presentation which he entitled ‘Our thoughts are ours, their ends none of our own – Are there ways to synthesise materials beyond the limitations of today?’

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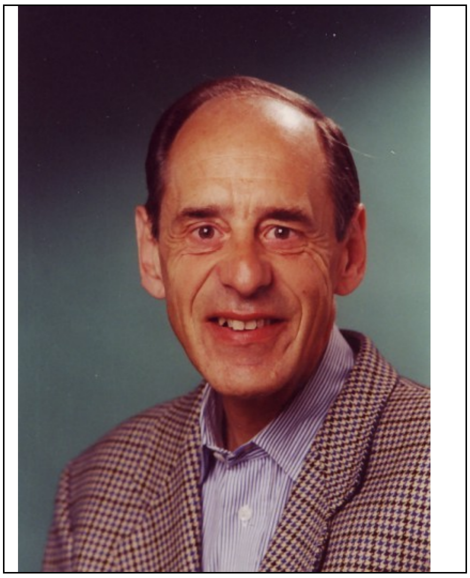
Our thoughts are ours, their ends none of our own – Are there ways to synthesise materials beyond the limitations of today?

Professor Herbert Gleiter
Acta Materialia Gold Medal 2007



The methods available today to modify the structure and properties of crystalline materials may be divided into the following two groups: modifications arising from the introduction of lattice defects and modifications arising from alloying of two or more components.

In materials with grain sizes of 1mm or more, the introduction of lattice defects modifies the microstructure. However, the modifications of the atomic structure are limited to less than 1 volume percent of the material. The way to modify the atomic structure by up to 50 volume percent of a material by introducing defects was opened by reducing the crystal size of polycrystalline materials to a few nanometers. Materials of this kind are called nanocrystalline, or nanostructured materials. The step towards modifying the entire atomic structure of solid materials seems to be possible by means of naonoglasses. Nanoglasses are glasses that are generated by consolidating nanometer-sized glassy spheres at high pressure, of several GPs. The existing structural investigations on metallic nanoglasses as well as studies by means of molecular dynamics suggest that nanoglasses consist – in the as prepared state – of the following two structural components. Glassy regions – resulting from the consolidation of spheres – and interfaces between the glassy regions. In these glassy/glass interfaces, the free volume is enhanced and nearest neighbour co-ordination deviate from the ones in the glassy regions. If these nanoglasses are annealed, the enhanced free volume in the glass/glass interfaces seems to delocalize and, thus, modifies the atomic structure of the entire material. In fact it is found that, after long annealing time, nanoglasses consist of a surface region with an enhanced density (due to a high hydrostatic pressure) and a glassy core region with a significantly – up to 10% - reduced density. In other words, nanoglasses may pave the way to tune the free volume, density, of glasses at constance chemical composition.

The modifications of solid materials by alloying may be divided into the following two groups: components that can be alloyed by melting followed by solidification, and alloys of components that are immiscible in the solid state, e.g. alloys of metals and ionics such as Au-NaCl. The preparation of alloys of this type seems attractive because they are likely to exhibit new properties. So far, apparently two approaches have been considered for preparing such alloys, In the first approach, applicable to systems with mobile charge carriers, electronic screening effects at interface boundaries are utilized, If nanocomposites of immiscible components are prepared with a crystal size comparable to the electronic screening length, the electronic structure of the entire specimen is modified due to the screening effects. As has been shown, this modification may result in the formation of solid solutions of conventionally immiscible components, eg. of Ag and Fe. In systems without mobile charge carriers, vapour deposition of ions of one of the components onto an electrically charged substrate may be used to generate solid solutions.