PT-1

Enhancement of Plasticity in Bulk Metallic Glasses with Atomic Scale Heterogeneity

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There are many ways to improve performances of metals and alloys by controlling alloy composition and/or their processing routes. The metallic glasses, a fully non-periodic structure, have higher strength close to Frenkel's theoretical limit of a tenth of the shear modulus and lower Young's modulus, which makes these materials as one of the potential candidates for structural application. Therefore, the emergence of bulk metallic glasses (BMGs) with a unique combination of properties has been an important part of the materials science arena over the past decades. However, one of the major drawbacks of BMGs is the limited global room temperature plasticity. Unlike in the case of polycrystalline metals in which the plastic strain energy can be accommodated through many pathways, the extent of the plastic deformation in BMG is dominantly dependent on the total number of shear bands (SBs) generated during deformation. Thus, methods for improving the plasticity of BMGs revolve around the question of how to generate a large number of SBs and how to impede their sudden propagation.

Here, it will be focused on the optimization of compositions and processes for BMGs or BMG matrix composites with enhanced plasticity. In particular, it will be proposed that atomic scale heterogeneity originated by either embedded quasicrystal-nuclei or minor addition of element having significantly different enthalpy of mixing with constituent elements can improve plasticity of BMGs. The heterogeneity can be quantified and evaluated by fragility index, m, which closely relate to viscous flow of the BMG during deformation. Indeed, this insight is central if the correlations are to be used in the development of BMGs with high glass-forming ability and plasticity, which may contribute to BMGs receiving a great attention as a new class of structural materials. BMG is dominantly dependent on the total number of shear bands (SBs) generated during deformation. Thus, methods for improving the plasticity of BMGs revolve around the question of how to generate a large number of SBs and how to impede their sudden propagation.

Keywords: Bulk Metallic Glass, Heterogeneity, Plasticity, Fragility

PT-2

Design and Development of Multfunctionalized Titanium Oxide Nanotube for Environmental and Energy Applications

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Titanium oxide (TiO2) nanotube(TNT) with open-end nano-scaled tubular structure of outer diameters of around 8-10nm can be synthesized by using simple and low temperature solution chemical route without using any template (Kasuga et al., 1998). Because of synergetic combination of low-dimensional nano-structure and physicochemical aspect of TiO2, excellent multifunctionality is expected. In this paper, performances and characteristics of TNT such as environmental purification and energy creation materials will be discussed in relation to processing and unique low-dimensional nanostructures.

It was found that the H2 generation rate under the UV light irradiation to water-NT system was higher than that of conventional TiO2 nanoparticles, due mainly to the high specific surface area and unique photochemical characteristic of the TNT.

As the environmental friendly function, it was firstly discovered from the degradation test of organic molecule (methylene blue, MB) in solution using TNT that the MB degraded without any irradiation of UV as well as visible light (i.e. under the dark condition), indicating that the NT can adsorb organic molecules. In addition, the adsorbed MB was decomposed by the further UV irradiation. Adsorption isotherm analysis indicated that the saturated volume of adsorbate for the as-synthesized TNT was fairly large. In addition, modification of TNT by doping could enhance the adsorption performance. On the other hand, photocatalytic performance was increased by heat-treatment, while the adsorption property was decreased. It indicated the trade-off relation existed between these two properties for the TiO2 nanotube. Consistence of adsorption and photocatalytic properties could also be confirmed for gaseous molecules such as acetaldehyde. These results clearly indicate that the TiO2 nanotube is the promising multifunctional oxide nanotube which has both excellent photocatalytic and molecular adsorption properties in one material.

Keywords: titanium oxide, nanotube, chemical synthesis, photocatalytic properties, molecular adsorption, hydrogen generation