Local and effective properties of metallic-glass-based nano-composites – Theoretical approach

H. Hermann

IFW Dresden, Institute for Complex Materials, P.O. Box 27 01 16, D-01171 Dresden, Germany

E-mail address: h.hermann@ifw-dresden.de,
phone: +49 (351) 4659-547
fax: +49 (351) 4659-452

Abstract

Systems consisting of a glassy matrix and nanocrystalline inclusions are considered. The peculiarity of the nanoscale is taken into account defining an interphase between particle and matrix as a third phase with different properties. The theoretical treatment is based on the classical composite sphere assemblage model which is extended to matrix-inclusion-interphase systems. Expressions for the effective elastic constants and the effective thermal conductivity of nanocomposite materials are derived. The results quantify the interplay of local and effective properties of nanocomposite materials and establish geometry mediated relations between elastic and thermal properties. The method is applied to hypothetical bulk metallic glass (BMG) nanocomposites generated from known monolithic BMGs. It is shown that the interphase has significant impact on the effective properties of BMG based nanocomposites. Cross property relations between the ratio of shear and bulk modulus on the one hand and the thermal conductivity on the other hand show that different plastic behaviour of BMGs can be discussed in terms of the presented theoretical results.