INFLUENCE OF THE INTERFACE AND THE MICROSTRUCTURAL LENGTH SCALE ON THE GRID INDENTATION

Petr Haušild, Czech Technical University in Prague, Faculty of Nuclear Sciences and Physical Engineering, Department of Materials, Trojanova 13, 120 00 Praha 2, Czech Republic
petr.hausild@fjfi.cvut.cz
Jaroslav Čech, Czech Technical University in Prague, FNSPE, Dept. of Materials, Czech Republic
Aleš Materna, Czech Technical University in Prague, FNSPE, Dept. of Materials, Czech Republic
Jiří Matějíček, Institute of Plasma Physics, Za Slovankou 3, 182 00 Praha, Czech Republic
Jiří Nohava, Anton Paar TriTec, Rue de la Gare 4, CH-2034 Peseux, Switzerland

The instrumented grid indentation of structurally heterogeneous materials using Oliver-Pharr method is frequently employed in order to characterize the properties of individual phases as this method is available in practically all commercial devices. However, when applying the statistical evaluation of results, the presence of boundary-affected results leads to the bias of the distribution, i.e. to the softer phase hardness and/or modulus overestimation together with the underestimation of harder phase values. The indentation in proximity of the interface cannot always be completely avoided – in the grid indentation the position of some indents can inevitably coincide with the phase boundary which can, moreover, be hidden below the indented surface.

The aim of this paper is to shed some light on the effect of indentation in proximity of the interface on the statistical distribution of the grid indentation data. A case study on material composed of two phases with distinctly different hardness and Young's modulus is presented. As an experimental material was chosen tungsten-copper composite. Samples were prepared using spark plasma sintering from pure metallic and ceramic powders which resulted in a sharp interface with abrupt change of material properties.

The influence of depth of penetration and microstructural length scale on the measured hardness and/or modulus was integrated in the statistical analysis of the grid indentation data. The conditional probability of the indentation in the (affected) interfacial area was incorporated into the statistical distribution function based on the profile estimated by the finite element analysis and by the experimental study on the model material with the sharp interface. The unbiased (intrinsic) properties (including indentation size effect) were subsequently extracted from the experimental grid indentation data.

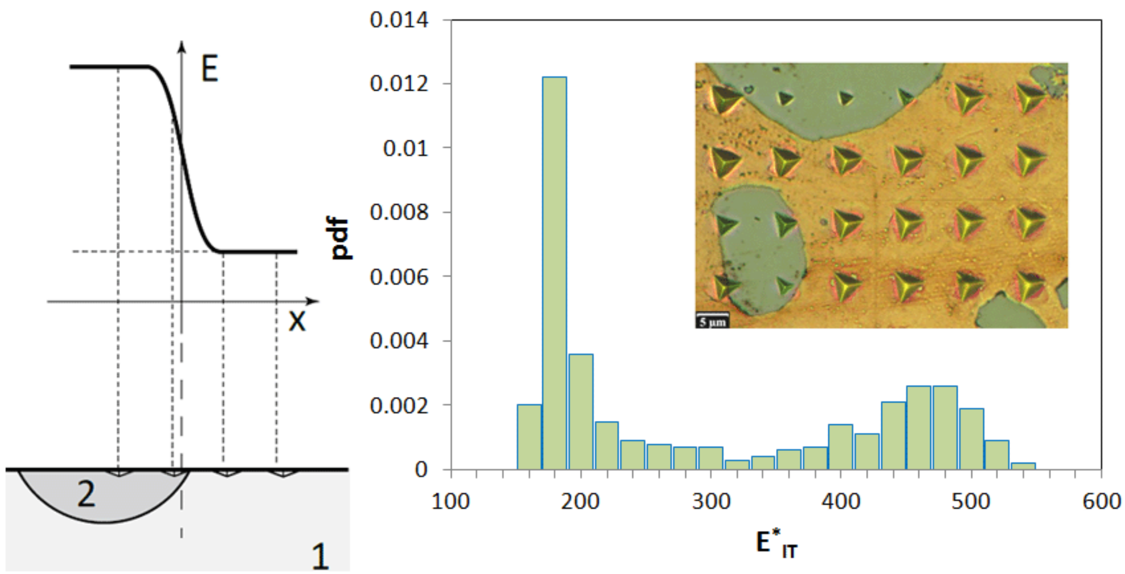

Figure 1 – Effect of the indentation near the interface on the measured Young's modulus distribution.

Acknowledgement: This research was carried out in the project 14-36566G (Czech Science Foundation).