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E.L. Kossovich, F.M. Borodich, S.J. Bull, S.A. Epshtein

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Substrate effects and evaluation of elastic moduli of components of inhomogeneous films by nanoindentation

E.L. Kossovich[1*], **F.M. Borodich**[2], **S.J. Bull**[3] and **S.A. Epshtein**[1]

[1] Laboratory of Physics and Chemistry of Coals, Mining Institute, National University of Science and Technology "MISiS", 119049, Leninsky pr.4, Moscow, Russia

[2] School of Engineering, Cardiff University, Cardiff CF24 3AA, UK

[3] School of Chemical Engineering and Advanced Materials, Newcastle University, Newcastle upon Tyne NE1 7RU, UK

[*] Corresponding author: e-mail: E.Kossovich@misis.ru

Abstract

Depth-sensing nanoindentation (DSNI) is a very popular technique that is used for evaluation of mechanical properties of both homogeneous thin films and bulk material samples. Recently it has been proposed by the authors to apply the DSNI to components of highly inhomogeneous materials that could contain pores and cracks. The extended techniques assume that the DSNI is applied to very thin films (the thickness is about 10–20 μm) of the tested inhomogeneous material glued to a transparent rigid substrate. The combination of DSNI and transmitted light microscopy allows us to visualize the regions of tested components. Because we study not a bulk material sample but rather a thin films glued to the substrate, the approximating functions have to be used to extract the real elastic modulus of the tested component. We present the results of evaluation of elastic moduli of coal samples at varying depth of maximal indentation using seven approximating functions. Comparing the experimental values with the results of approximations and calculating statistical characteristics such as the residual sum of squares and the coefficient of determination, it was found that the most appropriate are the exponential decay function and a function based on power-law approximation.

Key words: depth-sensing nanoindentation, mechanical characteristics, glue, substrate, coal films