Application of dilatometry with modulated temperature for thermo-mechanical analysis of antiwear coating/substrate systems

P. Myśliński[1] , Ł. Szparaga[1], P. Kamasa[2], A. Gilewicz[1], J. Ratajski[1]

[1]*Koszalin University of Technology, Koszalin, Poland*
[2]*Wigner Research Centre for Physics, Research Institute for Solid State Physics and Optics, Hungarian Academy of Sciences, Budapest, Hungary*

piotr.myslinski@tu.koszalin.pl

Modern vacuum-plasma surface modification technologies of tools for metal and wood machining are based inter alia on the deposition of thin gradient and multilayer coatings with a thickness of several micrometers. Exploitation of tools are frequently carried out in complex tribological nodes, where next to mechanical loads, there are significant changes in temperature at the interface of the tool/workpiece material, hence the knowledge of the stability of the coatings operating under these conditions is an important criterion used in the processes of wear resistant coatings technology optimization. One of the important issues in this respect is understand the mechanisms of thermo-mechanical interactions between the individual layers of multilayer structures through the analysis of changes in thermo-mechanical properties of these structures as a function of temperature and internal stresses. In the paper the objects of research were three types of gradient PVD coating / molybdenum substrate systems, for which time courses of amplitudes of elongation and temperature A_{DIL} and A_T and equivalent thermal expansion coefficients CTE_{AC} *and* CTE_{DC} of the systems were measured. Experimental measurements were made using a temperature-modulated dilatometry and using concepts of Dynamic Load Thermomechanical Analysis (DL TMA) and Dynamic Mechanical Analysis (DMA). For tested systems have also been calculated the phase shift between the elongation of the system and its temperature, which in combination with the knowledge of time courses A_{DIL}, A_T, CTE_{AC} *and* CTE_{DC} enables to evaluate and compare their thermo-mechanical properties. In addition, using the concepts of transition function describing the continuous change of physical and chemical parameters as a function of the spatial variables and FEM for each of the systems were determined the distributions of deformations and thermal stresses.