US-CZECH MUTUAL PHD PROGRAM IN FRICTION MATERIALS

Zdenek Weiss[1]

The mutual program for PhD students was established in 1999 as a basis for research collaboration between the Center for Advanced Friction Studies of Southern Illinois University at Carbondale and the Central Analytical Laboratory of the Technical University of Ostrava, Czech Republic. The program has been being funded from the two main sources: from the National Science Foundation for the U.S. side and the Czech Academy of Sciences for the Czech side. The primary object of the program is to maximaly improve training conditions of PhD students by enabling them to use research facilities and labs at both institutions. The research and corresponding PhD program is divided into two groups. The first group is oriented on polymer-bonded composite friction materials and the second one on the carbon-carbon friction composites. Nevertheless, both groups are aimed at understanding of friction process fundamentals, analyzing real chemical and physical processes on the friction surface and allowing tailored design of advanced friction materials. The two year mutual research program has already brought several positive results. One PhD student has found out the following relation between vermiculite structure state and temperature of the friction surface for composites containing vermiculite: (1) Pure vermiculite and vermiculite in phenolic resin bonded composite materials is sensitive to heating history. Basal interplanar spacing d(001) varies as a function of applied annealing temperature. This relation can be used for estimation of temperature in the vicinity of the friction surface. (2) Pure vermiculite rehydrates if the heating temperature does not exceed 700oC. If embedded in a phenolic resin matrix, rehydration ability of vermiculite is limited and depends on vermiculite/resin content ratio. (3) The maximum detected temperature on the friction surface of investigated samples was 900°C. The another PhD student has developed computer programs for modeling of XRD patterns of graphite polytypes with various content of stacking faults and for XRD determination of crystallite sizes in carbon materials. This approach is related to evaluation of friction and wear of carbon materials, because the effect of crystallinity and degree of structure ordering of carbon matrix are very important parameters. A progressive change of the carbon crytallinity could be controlled by a slow increase of the heat treatment temperature in which the preferred molecular orientation or stacking order of the basic graphene package would change from two dimensional (turbostratic carbons) to tridimensional order (graphitic carbons). This sudden change usually occurs at higher temperature (> 2400 C). This structural transition leads to significant increase in terms of thermal and mechanical properties of carbon materials.

[1] Central Analytical Laboratories , VSB - Technical University of Ostrava