CONTACT AND DEFORMATION MECHANISMS OF SEMICONDUCTORS AND CERAMICS AT THE NANO TO MICRO SCALE

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Abstract *¾ Semiconductors, such as silicon and germanium, and ceramics such as silicon nitride and silicon carbide, when subjected to extreme pressures, such as that which occurs during high pressure contacts involving friction and wear, undergo phase transformations to high pressure states. Generally, these high-pressure phases are metallic rather than semiconducting or insulating. Also, these high pressure phase transformations are metastable and only exist for the duration of the applied load, i.e. when the load is removed the high pressure states back-transform to another state, usually related to a stable-equilibrium phase that naturally exists at standard room conditions (atmospheric pressure and temperature). These high-pressure phases, and their transitions, are important for friction, wear and tribology in that the contacting material is in-fact these high-pressure phases during these processes. Therefore, in the analysis of these processes (friction, wear and tribology) with these materials (semiconductors and ceramics) it is the material properties of their high-pressure phases that are important physical parameters to analyze the various process mechanisms.*

Index Terms ¾ High Pressure Phase Transformations, Semiconductors, Ceramics, Ductile-to-Brittle Transition.

Most practitioners (and reviewers of this present work) working in this field are unaware of the high-pressure phase transformation phenomenon associated with these nominally brittle materials. It is the high pressure metallic phase of these materials which gives rise to their ductile response during mechanical loading as occurs during indentation and scratching (and cutting or machining) testing. Therefore, characterization and understanding of this fundamental phenomenon, related to frictional processes, is vitally important and necessary. This knowledge must be disseminated and transferred to the academy faculties (professors and researchers), students and industry. The program described in this paper includes collaboration between academia (University of North Carolina at Charlotte), industry (Third Waves Systems and Caterpillar), and government (National Science Foundation) that promotes this strategic alliance to develop fundamental understanding and to transfer this knowledge to the larger community of interest.

Additionally, the current program includes an international component. International collaboration includes: Wei Gao of Tohoku University, Sendai Japan, Hideo Shibutani of Toyohasi University, Japan, Keith Puttick of Surrey University, in the UK, and SKF Bearings-Sweden.

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