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Materials Tribology: Reliability of Electrical Contacts

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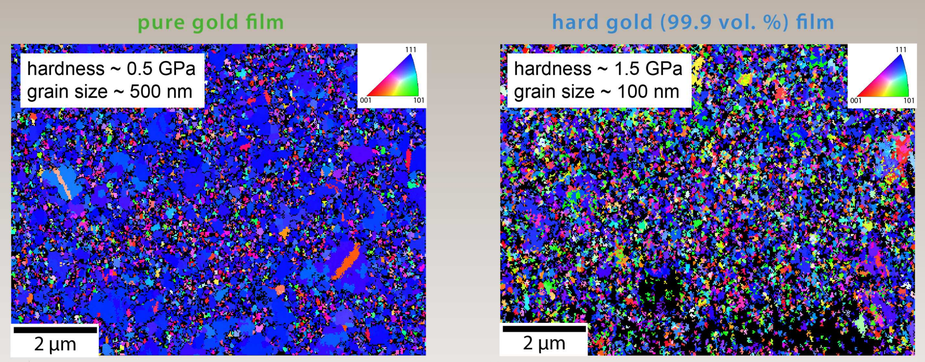
Problem: The tribological performance and reliability of electrical contact materials, primarily noble metals and alloys, in NW relevant engineering environments is fundamentally defined by two transient, coupled and highly complex problems:

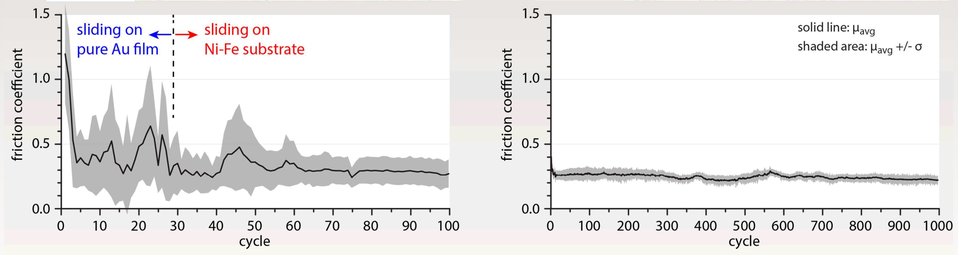
Microstructural Characteristics and Stability

Example: "hard" gold alloys

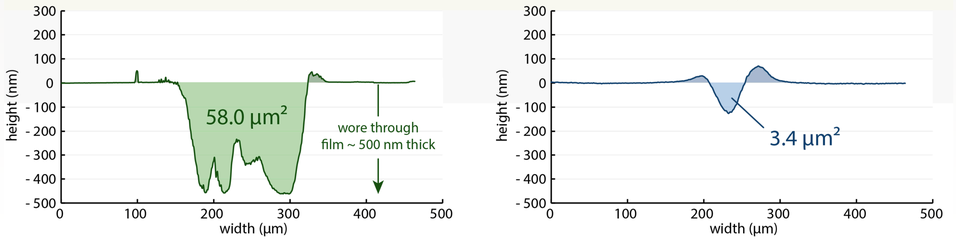
Drastic microstructural changes with minute additions of oxide or metal species



Drastic friction reduction with minute additions of a secondary species

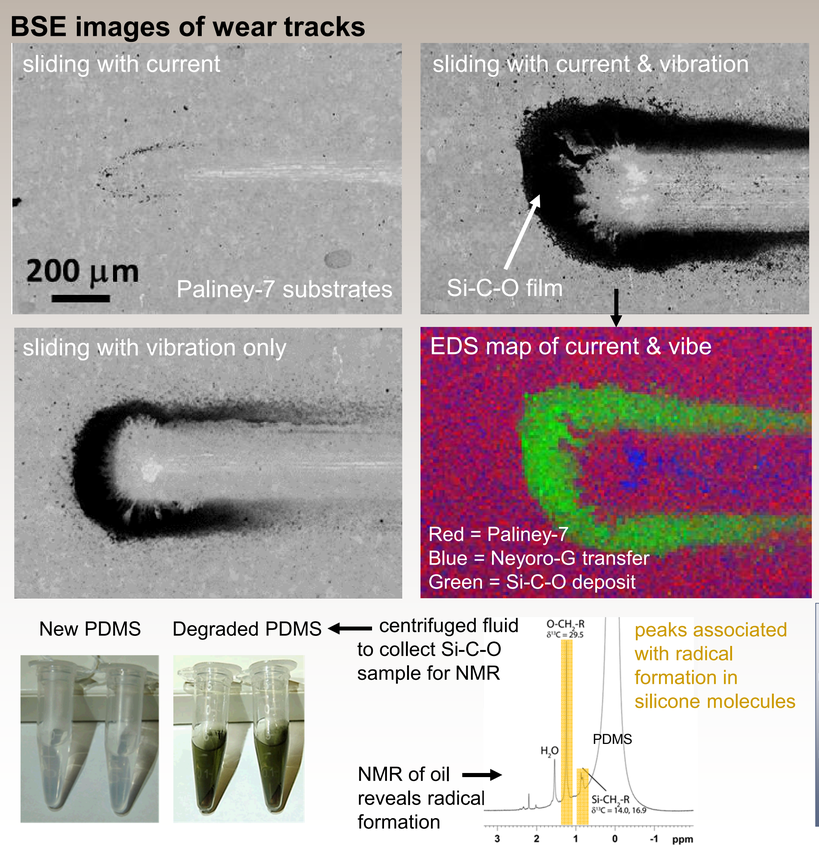


Several orders of magnitude wear reductions with minute changes in composition



Surface Chemistry and Tribo-Chemistry

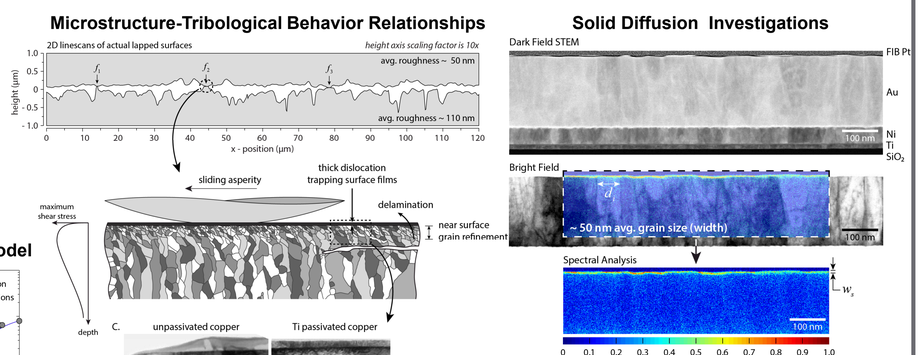
Example: degradation of silicone fluid (PDMS)



Dugger et al. Proc. IEEE Holm (2014)

Approach: Identify the structure-property relationships driving tribological behavior, enabling aging resistant materials-by-design (alloys and composites), improving the reliability and consistency of synthesis, and avoiding environment-driven surface chemistry changes resulting in undesirable friction, wear and electrical contact resistance.

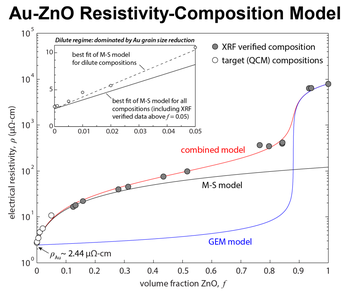
Microstructure-Tribological Behavior Relationships



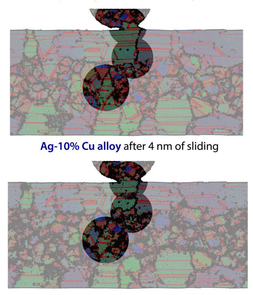
Solid Diffusion Investigations

Argibay et al., JAP (2012)

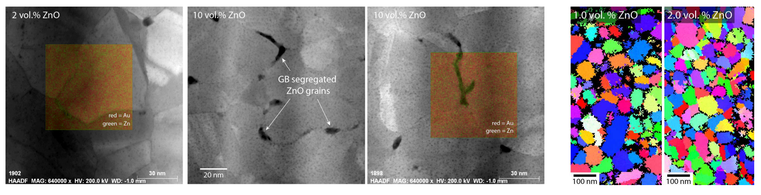
Au-ZnO Resistivity-Composition Model



Microstructural Evolution in Contact (MD)



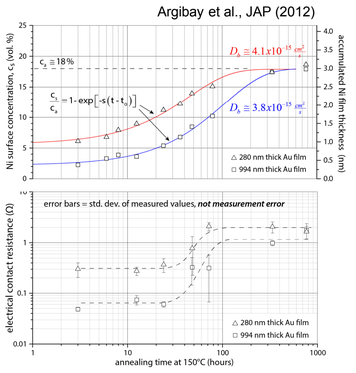
New Materials: Oxide Hardened Gold Composites



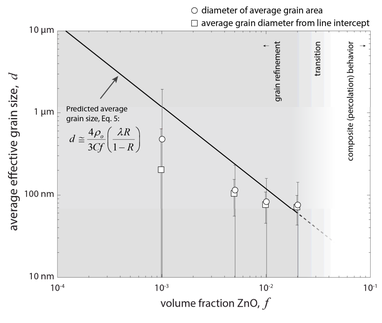
Accomplishments: (1) Experimental and computational resources exercised to create a generalized model of metal wear and friction behavior. (2) Establishing solid, vapor and liquid lubricant solutions with superior stability and performance to those in use. (3) Developing next generation in situ electro-tribological testing platforms and methods.

Predictive Solid Diffusion Aging Models

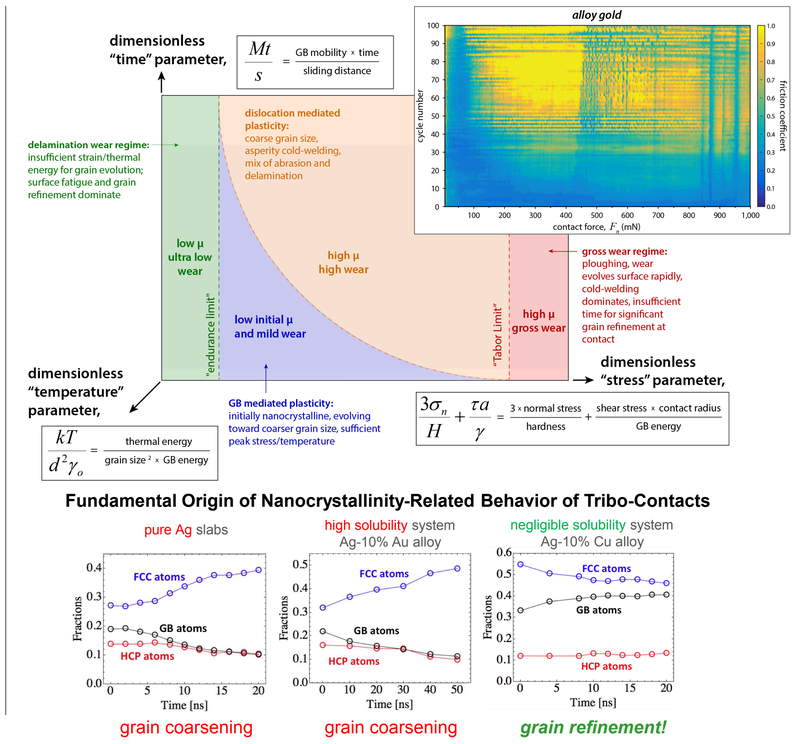
Argibay et al., JAP (2012)



Predictive Hardness/Composition Relationship for MMCs



Generalized Tribological Behavior Map for Metal Contacts



Fundamental Origin of Nanocrystallinity-Related Behavior of Tribo-Contacts

Impact: Tribology S&T spans fundamental to applied research, establishing the structure-property relationships that define interfacial characteristics such as friction and wear, and guides the development of new materials. The capabilities developed regularly impact significant finding investigations, component design, and selection of materials for new electromechanical NW devices.

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National Nuclear Security Administration

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