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Tribochemical studies at the nanometer scale: synergisms of mechanical and chemical forces[1]

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The manipulation of matter on small size scales dominates a number of potential applications in nanoscience and nanotechnology. The forces and potentials available to break and reestablish bonds between ions, atoms, and molecules becomes greatly expanded when we consider combining stimuli. Our efforts on combining (mechanical + chemical) or (mechanical + radiative) stimulation aims at understanding the resulting synergisms in, for example, dissolution and/or deposition of material. We show that we can measure the kinetics of chemical mechanical wear (e.g., polishing) with a single asperity (the tip of an Atomic Force Microscope) on substrates of single crystals, amorphous materials such as silicate glasses,polymers, crystalline silicon, and on polycrystalline oxides, nitrides, and carbides in controlled chemical media. We find that although the mechanics are relatively straight forward to model, the *dependence* on the applied normal force, the applied stress, the solution composition, the solution temperature, the duration time of the wear experiment, and the relative velocity of the AFM tip and substrate can be complex. With care, we have been able to properly measure and model the tribochemical wear on model systems. We present these studies and include new results on technologically interesting materials such as single crystal Si(100). We also present results on the use of an AFM tip to localize layer-by-layer growth of single crystals of inorganic carbonates, sulfates, and phosphates in saturated aqueous solutions.

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