WEAR MECHANISM OF OLIVINE AT THE SMALL-SCALE: AN *IN SITU* TEM STUDY

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The study of tribology includes wear, friction, and lubrication of interacting surfaces in relative motions. Since the function, efficiency, and lifetime of many engineering components depend on the appropriate friction and wear properties, the study of tribology has significant practical importance. However, traditional tribology tests are limited by the inability to observe real-time progress of the sliding contacts and wear mechanism. Recent developments in small-scale devices, particularly piezoelectric and MEMS-based actuators, aid in conducting scratches at the micro- and nano-scale in the TEM. Olivine is magnesium iron silicate (Mg^{2+}, $Fe^{2+})_2SiO_4$ and the most abundant mineral in earth's upper mantle, which comprises the bulk of the planet's tectonic plates. Although the structure of olivine has been intensively studied by mineralogists and geophysicists, the frictional and mechanical properties particularly damage evolution at the small-scale of sliding contact is unknown. In this study, a bulk olivine sample was wedge polished and then fib-milled to prepare electron-transparent regions. A wedge diamond indenter of 100 nm radius and 3 um length was used to make sliding contact using a PI 95, TEM PicoIndenter. Multicycle scratch tests were conducted to understand wear behavior. During the wear passes, the kinetic friction coefficient remained relatively constant near 0.1 and substantial dislocation plasticity occurred in the sample. Each pass showed nucleation of additional dislocations which were arranged in a symmetric array along the wear path as shown in fig. 1. The talk will present a theory of friction and deformation behavior that are applicable to geological materials.

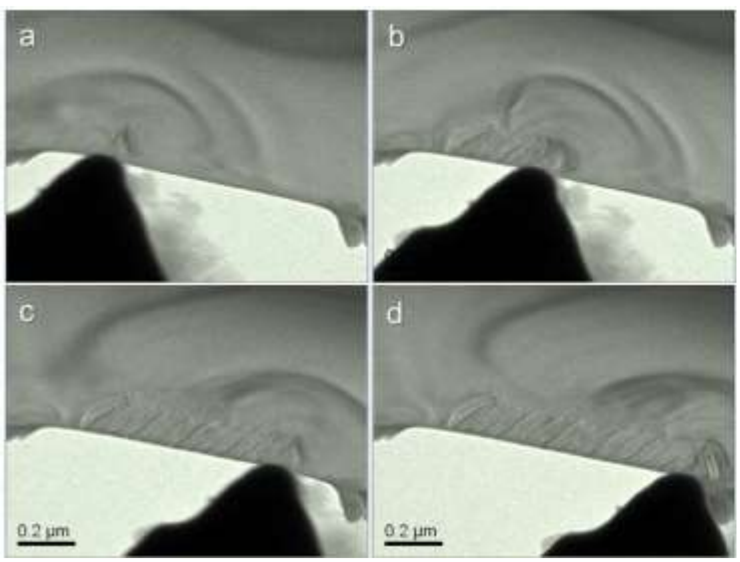

Figure 1: Plastic deformation of olivine along sliding direction.