Wear Resistance Evaluation and Debris Generation Study through Nano Wear

Nano scale wear that may be conducted on a nanoindenter with in-situ SPM imaging capability, such as the one equipped in Ebatco's Nano Analytical and Testing Laboratory (NAT Lab), is also called scanning wear. Scanning wear is a unique format of wear that removes material from the surface of its wear counterpart through raster scanning a probe under controlled load over a defined area. Scanning wear differs from other traditional wear formats such as reciprocating wear, fretting wear, fatigue wear, and corrosion wear by its distinct characteristics. Scanning wear involves very small amount of material loss; it typically is done under load in the nano-Newton to milli-Newton range; the contact area can be at nanometer level; and the sliding distance may be limited to a few tens of microns or less. During a scanning wear test, a pre-selected load is applied to an indenter tip and the tip is raster scanned by the SPM scanner over a pre-selected sample area at a user-defined scan rate. After a certain number of scan passes over the area, a larger area will be imaged at a much lower load in order to capture the three dimensional topography of the wear crater. From the image, wear volume can be determined using image processing software.

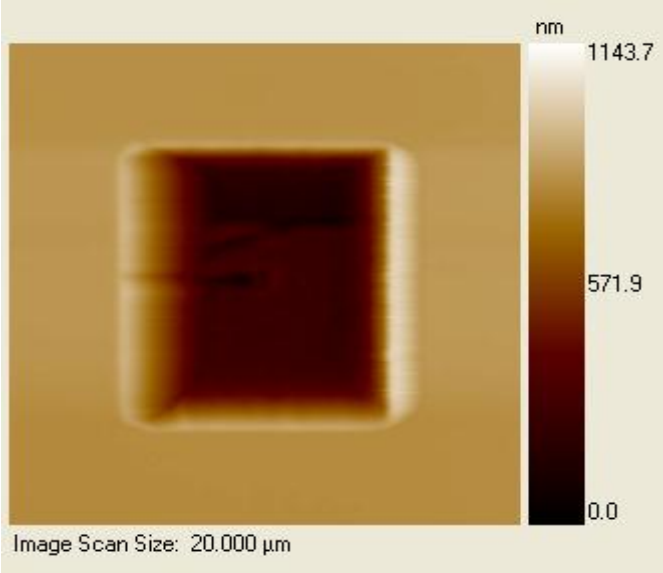

Figure 1. Center wear crater and surrounding area used for wear analysis on a polymer film on Si substrate sample.

Because scanning wear works with very small volume of materials, small structures can be tested that would otherwise be too small or too thin for conventional wear testing methods. Other applications of scanning wear include simulation of materials or devices that undergo light load or modest wear, wear study of ultra thin films, traditional wear mechanism investigation at nano-

scale, simulation of single asperity scratch, plowing and fatigue wear, tribochemical research of wear surfaces under lubricated conditions, and wear debris generation study.

The scanning wear tests demonstrated here were carried out on a polymer thin film on Si substrate sample and a polyethylene implant cylinder that had been soaked in water. From the scanned images (Figures 1 and 2), the wear volumes were calculated using an imaging processing software. Knowing the number of passes, wear volume, scan size and the scan frequency, the wear rates were determined.

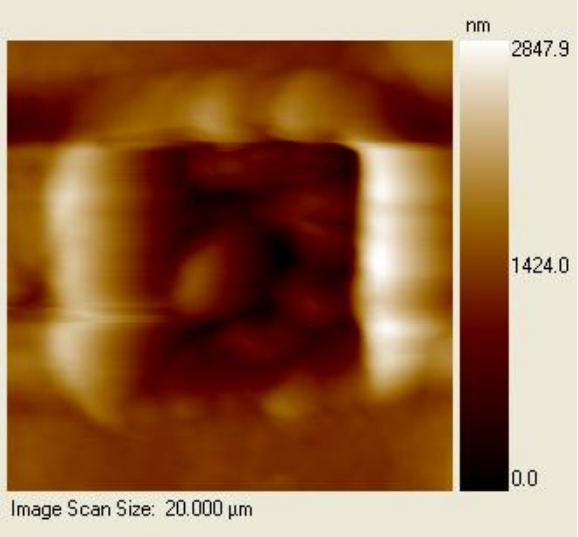

Figure 2. Center wear crater and surrounding area used for wear analysis on polyethylene specimen soaked in water.