Scratch Failure Characteristics of DLC Coating on M2 Steel

Diamond-Like Carbon (DLC) coatings are frequently used on parts in high performance applications to prevent surface damage or reduce friction of moving parts. DLC coatings can be applied to almost any material that is compatible with vacuum (due to the coating being applied via sputtering) and have many applications including electronics, automobiles, tools, shaving razors, and biomedical implants. The hardness and strength of the coating can vary greatly depending on how it was applied and any fillers that were used to reduce cost. Due to this high variability, characterizing the properties of such coatings can provide very useful information.

One method for characterizing the properties of DLC coatings is scratch testing. In this method, a sharp, conical probe made of diamond is dragged along the surface and subjected to an increasing force perpendicular to the coating surface. At some point, the coating will fail either by cracking or delamination. Knowing the critical load at which a coating fails, it is possible to compare the quality of different coatings.

At Ebatco, we tested a DLC-coated bar of M2 steel. The specimen was tested using a Micro-Scratch Tester made by CSM Instruments (Switzerland). The test was performed using a Rockwell indenter with a tip radius of 200 microns. The data is presented in Figure 1.

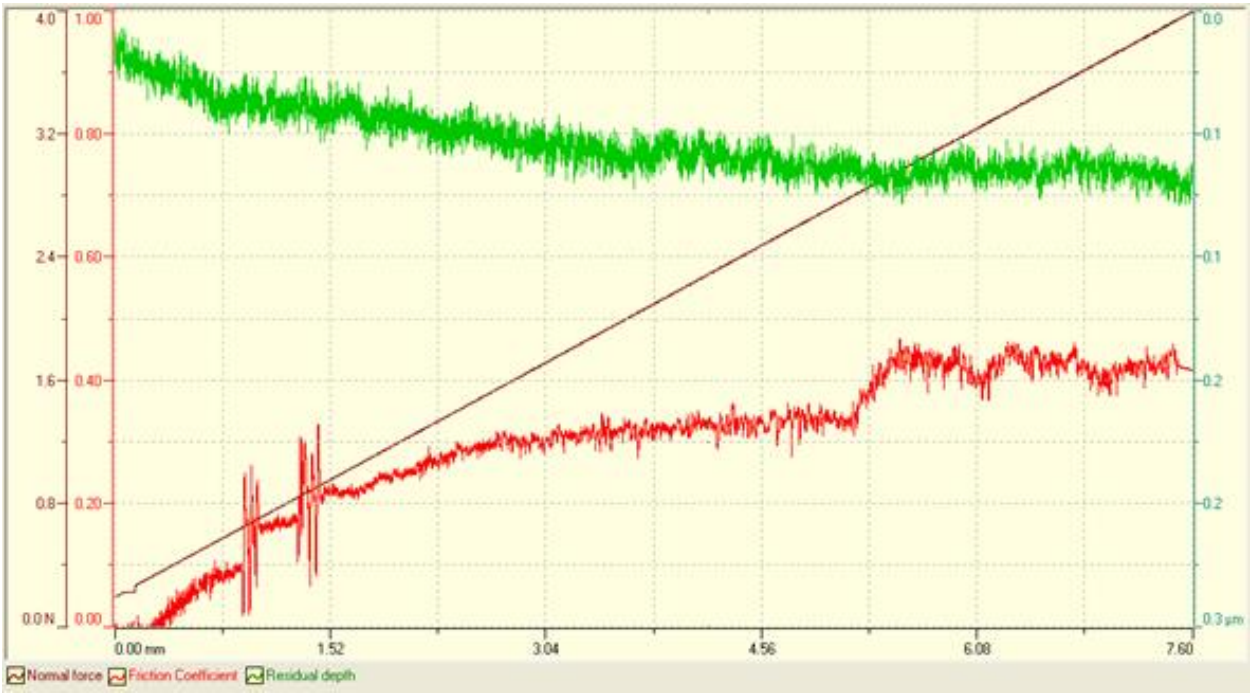

Figure 1. Scratch test data for a DLC coating on M2 steel.

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There are a couple of ways to identify critical loads when performing scratch tests. The most common techniques involve monitoring acoustic emission from the sample, looking for changes in coefficient of friction, or viewing the scratch with optical microscopy. From Figure 1, there is a large change in coefficient of friction around the 5.1 mm mark. Figure 2, below, shows the corresponding location of the scratch as viewed from an optical microscope. The failure location corresponds to a critical load of 2.83 N.

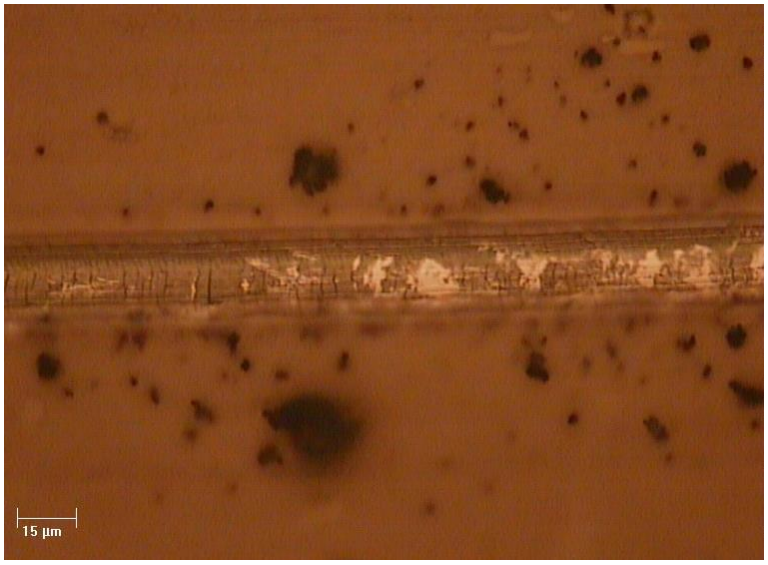

Figure 2. 25x magnified view of the critical failure location in the DLC coating.