Ebatco Nano
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Nano Brief

Happy New Year from all of us at Ebatco! We look forward to helping make your 2013 full of joy and success!

Ebatco

In the last newsletter, we have shared with you our office move and facility expansion. More exciting than that, this time we are pleased to announce two new additions to our technical team: Dr. Tyler Moersch and Mr. Peter Froehling. Welcome onboard!

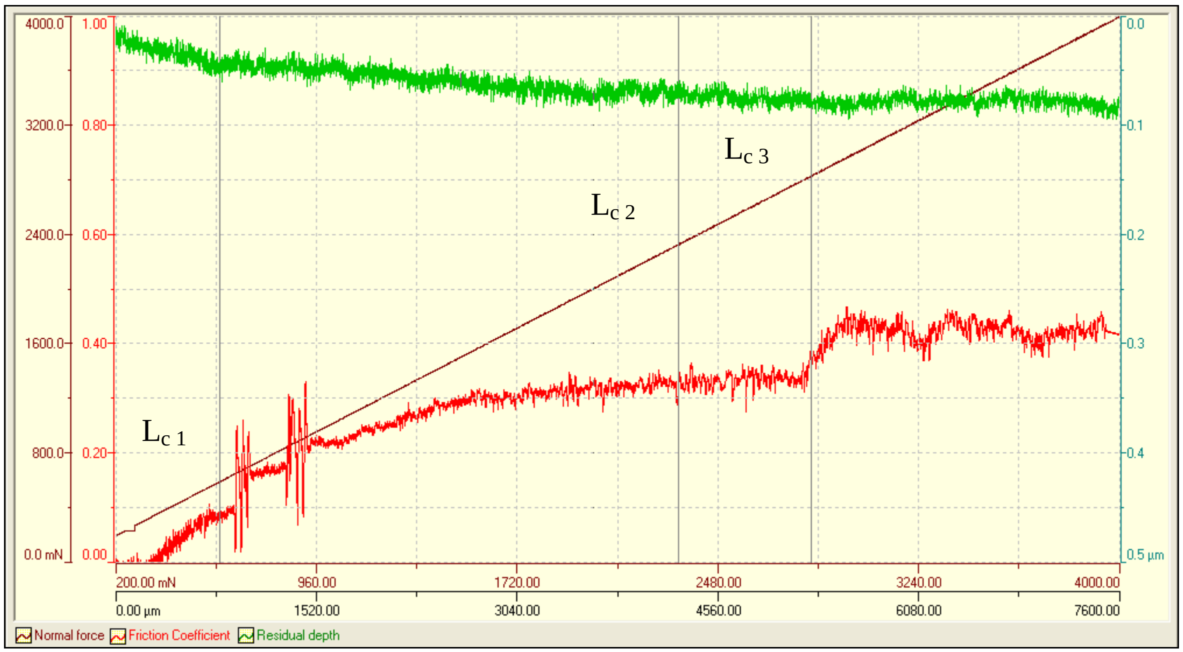
Dr. Moersch received his undergraduate degree in Chemistry from Claremont McKenna College in Claremont, California, his Masters in Chemistry and Ph.D. in Materials Chemistry from the University of Minnesota-Twin Cities followed by a post-doctoral appointment at Pomona College in Claremont, California. He has experience in chemical vapor deposition and atomic layer deposition, reactor design, sensor development, analytical instrument prototyping and materials characterization of thin films for chemical and physical properties. Dr. Moersch has worked in a wide range of fields including chemical deposition for microelectronics, micro-hotplate-based sensors, Raman spectrometer-based analytical systems for health-care applications and the materials chemistry of art conservation. Dr. Moersch will be expanding research and development at Ebatco, as well as assisting with customer projects and developing training materials based on Ebatco’s wide range of analytical tools.

Mr. Peter Froehling joined the Ebatco Nano Analytical and Testing Laboratory recently. Mr. Froehling is a graduate of the University of Wisconsin-Madison with a M.S. in Engineering Physics. He also holds a B.S. in Physics from Saint John’s University. Utilizing a diverse background in experimental and theoretical physics, Mr. Froehling is looking forward to providing custom solutions for our clients’ testing and measurement needs using Ebatco’s advanced instruments.

Case Study

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 environments 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 is deposited and its intended applications. Due to this high variability, characterizing the properties of such coatings can provide very useful information for the preparation process optimization as well as performance evaluation.

One method for characterizing the properties of DLC coatings is scratch testing. In this method, a diamond stylus that is subjected to an increasing normal force is drawn across the coating surface. At some point, the coating will fail due to increased normal and tangential stresses applied by the moving diamond stylus. The normal force applied to the scratching stylus at the point that a coating fails is called the critical load of failure.



Scratch test data for a DLC coating on M2 steel; the vertical grey lines mark the critical failure points and the corresponding normal forces are critical loads: $L_{c\,1}$, $L_{c\,2}$ and $L_{c\,3}$.

A DLC-coated bar of M2 steel was tested in Ebatco's Nano Analytical Test Lab using a Micro-Scratch Tester made by CSM Instruments (Switzerland). The scratch data is presented in Figure 1. There are several 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 and scratch normal displacement, or *post facto* observation via reflected light microscopy on the scratch track.

As can be seen in the graph above and optical images below, the DLC coating exhibited distinctive scratch failure characteristics along the scratch. Three critical loads at 0.59N, 2.33N and 2.83 N corresponding to the onsets of cohesive cracking, adhesive spallation and gross adhesive spallation were determined from the scratch data and the optical microscopic images. The changes in coefficient of friction and normal displacement in the test data correlate well with the optical observations at the three critical points of coating failure.

Optical micrographs of the scratch track showing the failure characteristics of the DLC coating on M2 steel; the centers of the scratch track images corresponding to $L_{c\,1}$ (left image, cohesive cracking), $L_{c\,2}$ (center image, adhesive spallation), $L_{c\,3}$ (right image, gross adhesive spallation).

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