



Ebatco Nano

A Bimonthly Newsletter

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Nano Brief

Ebatco will be exhibiting at the following upcoming events:

- November 5th – 9th, International Symposium for Testing and Failure Analysis 2017, Booth No. 520, Pasadena Convention Center, Pasadena, CA.
- November 5th – 9th, NIP/Digital Printing for Digital Fabrication 2017, Grand Hyatt Denver, Denver, CO, representing Kyowa Interface Science Co., Ltd.

Please stop by our booth to discuss the incredible world of nanomaterials, nanodevices, nanoinstruments, and nano/micro scale surface characterization with our staff scientists. We hope to see you there!

Ebatco

As we continue to grow our business and in an effort to expand our testing and analysis offerings in the chemical and metallurgical analysis areas, we have hired on new talents to expand our related programs and lab services. Please join us to welcome our two new additions to our technical team: Dr. Eric Smolensky and Dr. Yu (Joey) Zhao.

Dr. Smolensky received his doctorate in chemistry from the University of Minnesota – Twin Cities in 2012. He authored eight scientific publications in peer-reviewed, national and international journals, and his research focused on MRI contrast agent design and synthesis with strong focuses on nanoparticle surface modification and stabilization. After a brief stint performing cancer and metabolism research at the University of Texas – Southwestern, he left research to pursue his interest in personalized education and instruction. He has since returned to chemistry as an Analytical Chemist at Ebatco performing chemical analysis, working heavily with the newly acquired FTIR and Raman spectrometers. When Dr. Smolensky is not at Ebatco, he is most likely playing softball, volleyball, or walking around Lake Calhoun.

Dr. Yu (Joey) Zhao received his undergraduate degree in Materials Engineering from Central South University in Changsha, P. R.

China. He got his Master degree in Mechanical Engineering from Louisiana Tech University and his Ph.D. degree in Materials Engineering from Auburn University. Prior to joining Ebatco recently he worked as a postdoc at Michigan Technological University in Houghton, Michigan for four years. He has performed research in high temperature corrosion of metallic materials, surface modification of titanium medical implants, and synthetization of ZIF-8 coated gelatin microparticles. Dr. Zhao has worked in a wide range of fields including metallurgical analysis, materials corrosion and protection, and characterization of materials using various analytical tools. Dr. Zhao is expected to strengthen and further expand Ebatco's programs in metallurgical and failure analysis as a Materials Scientist.

In addition to adding staff members, Ebatco has just installed a WITec Alpha 300RA Combined Confocal Raman Microscope and Atomic Force Microscope (AFM) System. With this powerful tool, Ebatco is hoping to better support your chemical analysis needs.

Case Study

Both metallic and polymeric coatings play vital roles across a variety of industries, and these coatings must be sufficiently characterized in terms of their constitution, orientation, and thickness as all these variables significantly affect the properties of the coatings. For example, in the medical device industry, coatings must be at minimum characterized for uniformity, constitution, hydrophobicity/hydrophilicity, and biocompatibility. Paint finishes are often analyzed to determine hardness, hydrophobicity, and adhesion strength. Interestingly, and especially if the coating is nontransparent, measuring layer thickness is rather convoluted. Techniques such as Atomic Force Microscopy (AFM) and Scanning Electron Microscopy (SEM) could be used to determine layer thickness if the analyst dissects the sample to expose the layer, but these techniques are destructive, sampling size becomes an issue, and of course no molecular information is obtained (although an SEM/EDX could be used to map some elements on the exposed surfaces).

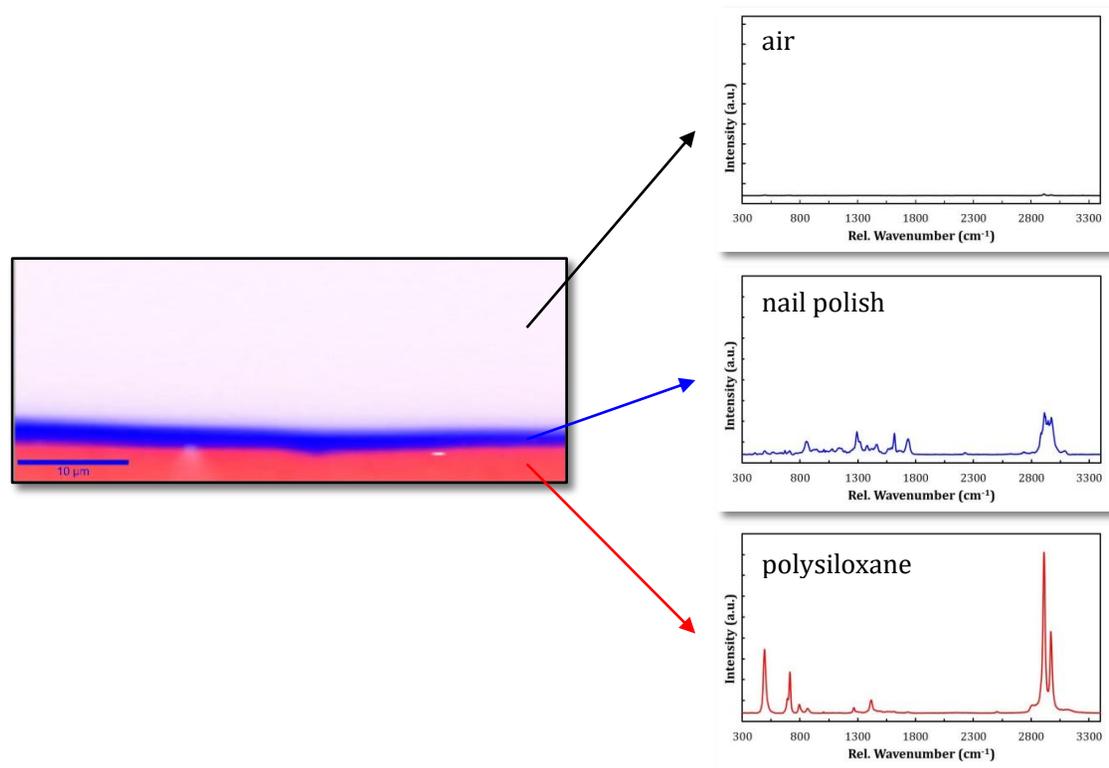


Figure 1. A Confocal Raman Microscopy image obtained from a depth scan of nail polish (blue) on a polysiloxane substrate (red). The depth scan covered a $50\ \mu\text{m} \times 20\ \mu\text{m}$ range at a pixel number of 20,000 and an integration time of 84 ms. The excitation laser wavelength was 531.7 nm with a $100\times$ lens ($\text{NA} = 0.9$). The basis spectra (right) were obtained by selectively averaging spectra from the three indicated sections of the depth scan. Vertical axes are equivalent for all three basis spectra.

Considering its ability to measure coating thickness and determine molecular structure and orientation, confocal Raman microscopy (CRM) is extraordinarily well-suited to characterize polymeric coatings. Furthermore, since the excitation source uses visible light, CRM is nondestructive and coatings can be characterized without damaging the sample (provided the laser power is low enough to prevent sample degradation). Due to its confocal design, the microscope only obtains data from samples in the focal plane of the microscope at a time. By changing the focal plane, for transparent samples CRM can obtain vertical information of the samples at a depth resolution of 500 nm. Thus, CRM becomes a powerful tool to map the chemical and molecular structural information in all 3 dimensions.

To illustrate how confocal Raman spectroscopy can characterize a coating in 3 dimensions, a thin layer of clear nail polish was brushed onto a polysiloxane substrate. The sample was then imaged using a WITec 300RA CRM. A depth scan ($50\ \mu\text{m} \times 20\ \mu\text{m}$) was performed, and the spectra of selected areas inside the depth scan were averaged to create three basis spectra. Each basis spectrum corresponded to one of the known constituents of the system: air, nail polish (which is a collective mixture of many substances), and the polysiloxane substrate. Spectral processing of the basis spectra can create an overlay to illustrate the spatial relationship of all three components of the system. The resulting image and the corresponding basis spectra are shown in Figure 1.

As can be seen from Figure 1, not only can the structures of the three component system be elucidated using CRM, but the thickness of the nail polish coating can be determined with high precision. In this case the thickness of the layer is non-uniform, decreasing from $2.2\ \mu\text{m}$ to $1.7\ \mu\text{m}$ over the $50\ \mu\text{m}$ length investigated. This is visually supported in Figure 1 by the thinning of the blue layer from left to right. A non-uniform layer thickness was chosen intentionally to illustrate the resolution imaging power of CRM. Layer thickness was determined using the $1700\ \text{cm}^{-1}$ band on the nail polish spectrum.

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