



Nano Brief

Since there will be no in-person tradeshows for the foreseeable future until Covid-19 gets under control, to maintain a good communication with you, in addition to this newsletter, we have established an online webinar series. The first webinar given in November of 2020 by Dr. Eric Smolensky on “Materials Analysis using FTIR and Raman Spectroscopy” was very well attended. The second webinar will be presented by Dr. Rebecca Tissot on “Theory and Practice of X-Ray Diffraction” and it will take place on March 17th. Please see the attached brochure for more information if you are interested in joining us then.

For your quick reference, the presented and future webinar topics are as follows:

1. Materials Analysis using FTIR and Raman Spectroscopy
2. Theory and Practice of X-Ray Diffraction
3. Root Cause and Failure Analysis of Materials
4. Powder XRD: From Sample Preparation to Data Analysis
5. FTIR and Raman for Unknown Identification
6. Nanomechanical Characterization of Thin Films and Coatings
7. Residual Stress Analysis Through XRD
8. Failure Analysis Using FTIR and Raman
9. Nanohardness and Elastic Modulus Determination through Nanoindentation
10. Crystallinity Determination Using XRD
11. FTIR and Raman Applications for Thin Films and Coatings
12. Scratch Resistance and Interfacial Adhesion of Thin Films and Coatings through Scratch Testing
13. X-Ray Reflectivity and Surface Roughness Analysis

14. 3D Chemical Mapping of Materials using FTIR and Raman
15. Friction, Wear, and Lubricity Testing at Micro- and Nanoscale
16. EDS Microscale Elemental Composition and Mapping

Ebatco

With growing customer base and increasing lab service demand, addition of new talents is warranted for Ebatco's successful operations. In order to keep up with and better serve our customers' needs, a new Technical Sales Engineer, Justin Kruger, has just been hired on. Please join us in welcoming him on board.

Justin obtained his Bachelor of Science degree in Chemistry in 2004, and his Master of Science degree in Synthetic Organic Chemistry in 2006, both from the University of Minnesota Duluth. After graduate school, Justin started his professional career as a lab spectroscopist at Cargill and had worked with a wide variety of analytical instrumentation. Continuing on his technical profession, Justin had worked as a contract QA/QC lab manager, and a HPLC Chemist in drug delivery for Medtronic and 3M. He transitioned into inside sales and sales support with Hysitron, Inc. where he gained knowledge on nanomechanical testing and material property characterization. Before joining Ebatco, Justin had been a regional sales manager selling and marketing advanced surface analysis instruments for Physical Electronics, Inc.

In his new Technical Sales Engineer role, Justin brings his strong scientific and technical background in chemical analysis and years of experience in understanding and serving internal and external customers. He is looking forward to meeting and connecting with everyone who is interested in knowing more about Ebatco, and to bridging you with Ebatco's excellence in technical consulting, contract lab services and nanotech enabling instrument products.

Case Study

Imaging Magnetic Materials using Magnetic Force Microscopy

Magnetic Force Microscopy (MFM) is a powerful scanning probe microscopy technique that is used to study magnetic properties or investigate features such as magnetic domains in a wide variety of sample types. Rewritable or re-recordable storage media has become increasingly prominent, and the demand to characterize magnetic surfaces has never been higher. With the ability to resolve features down to the nanometer level, MFM stands at the forefront of magnetic domain imaging and characterization. In this application note, a

magnetic tape storage medium is analyzed using single-pass MFM.

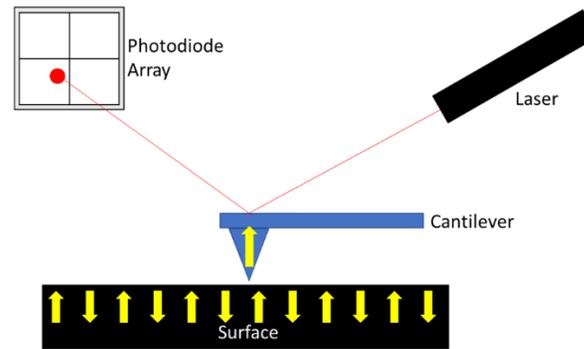


Figure 1. Schematic of MFM showing magnetic tip and sample interactions and measurement principle.

In a standard MFM scan, magnetic repulsions or attractions between a magnetic sample surface and a magnetic tip are measured, as shown schematically in Figure 1. During the scan, the tip is lifted off the surface to eliminate any tip deflection resulting from atomic repulsion or other short-range forces. By operating in oscillation mode, magnetic interactions between the sample and the tip manifest as changes in the phase lag: attractive and repulsive forces shift the phase lag in opposite directions, resulting in bright and dark areas on an MFM image. An MFM scan is analogous to a standard Atomic Force Microscopy (AFM) scan; however, some important distinctions are worth mentioning. Rather than using a standard AFM tip, a soft or hard magnetic tip is used for MFM. Additionally, rather than being in contact with the sample surface during the scan, the tip scans the sample at a fixed height above the sample surface.

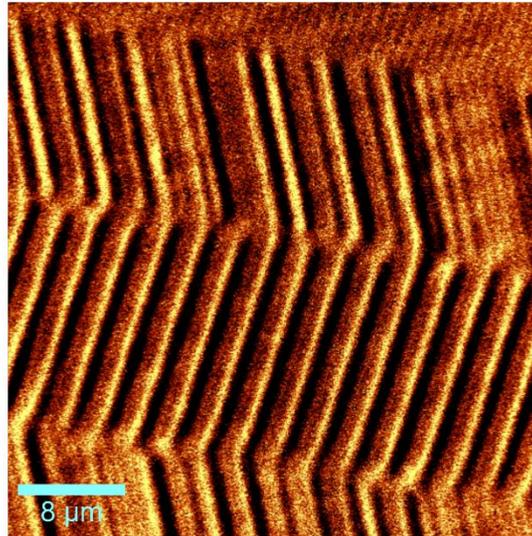


Figure 2. MFM image of data stored on a video recording tape.

Many recording devices, such as hard drive disks or video camera film, use magnetic domains to record data. Because these domains can be turned “on” and “off”, data can be rewritten into the media. Video camera film, as characterized here, has a flat surface suggesting a rather topographically featureless material. However, the phase image obtained during the MFM scan shows anything but a featureless material (see Figure 2). The bright stripes correspond to areas in which the tip-surface interaction is attractive, and the dark stripes correspond to areas in which the interaction is repulsive. Each one of these bright or dark stripes represents one bit of data stored on the media. Because it is an MFM scan, the distance between attractive domains can be calculated by creating a cross-sectional line profile across the image. The data obtained from such a line profile is shown in Figure 3. From the cross-section line profile data, it is observed that the attractive domains are approximately $2.6\ \mu\text{m}$ from one another.

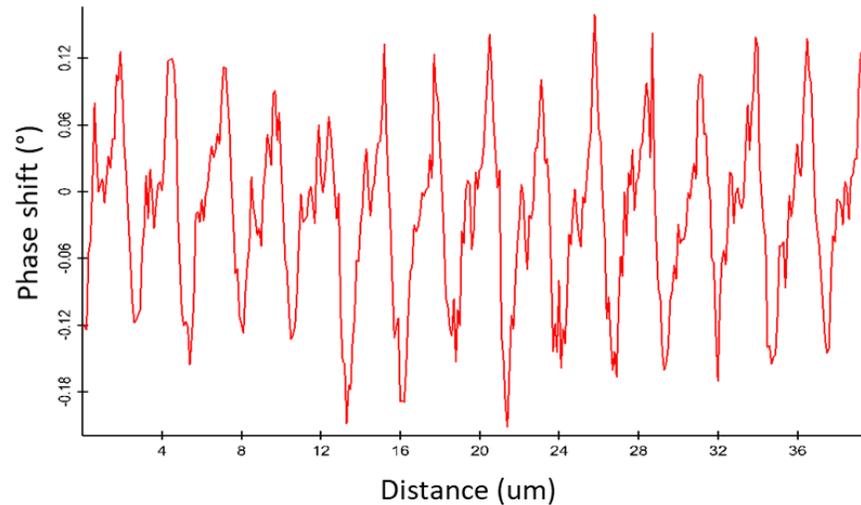


Figure 3. A cross-section line profile of the MFM phase signal taken perpendicular to the vertical magnetic domains.

The MFM instrument at Ebatco is capable of scanning areas approximately $200 \mu\text{m}^2$ and is currently outfitted with both soft and hard magnetic tips. With this setup, the instrument can characterize the magnetic domain morphology of metals, hard disks, magnetic nanoparticles, hard disk reconstruction, magnetic domain imaging, and magnetic materials in liquids. With such a powerful ability to obtain magnetic information about materials, MFM are expected to find even more applications from biochemistry (magnetic nanoparticles used for targeted drug delivery, magneto-thermal therapy, and *in-vivo* imaging) to electronics (quality control, process optimization, and R&D for new magnetic storage media) and a variety of fields in between.

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