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LECO MET-TIPS Ideas for Metallographic Procedures

Polishing Metallographic Samples

After sectioning, mounting, and grinding, polishing is the last step in the overall preparation process of metallographic specimens for microscopic examination. It removes the fine scratches and deformation left behind after grinding. While polishing cannot be categorized into a "one size fits all" kind of process, this article will share some helpful tips and advice that labs can use to improve upon existing processes, try new methods, and correct potential bad habits.

What is the Purpose of Polishing?

Polishing is similar to grinding, but on a finer scale. The ultra-fine abrasive particles in a polishing medium make miniscule cuts to shave off surface anomalies left from grinding to reveal the true structure underneath. This will give you a clearer picture of what's in your sample during microscopic analysis. The cleaner and smoother your polish, the more accurate your analysis will be.

Preparing to Polish a Sample

After the final grinding step, the specimen(s) should be thoroughly cleaned to remove loose grinding abrasives that would contaminate the polishing cloths. Mounted samples where the mounting media has separated from the specimen surface should be ultrasonically cleaned to dislodge grinding abrasive caught in the crevices. Hands should be washed to prevent dislodged abrasive particles from dropping off onto the polishing cloth. One loose grinding abrasive on a polishing wheel can create numerous unwanted scratches.

How to Polish a Sample

In a very basic sense, to polish a sample, you'll secure a suitable cloth to a polishing wheel, apply an appropriate polishing abrasive and lubricant, then polish until all traces of the prior surface finish are removed. However, polishing procedures can vary considerably from lab to lab. For instance, one lab may use as many as five polishing steps following the last grind while other labs may use only three, or even two. But every polishing process involves two steps—the intermediate polish and the final polish. The polishing step(s) immediately following a final grind is referred to as an intermediate polish.

The intermediate polishing step(s) are most commonly accomplished using either alpha alumina or a diamond polishing compound.

Intermediate Polishing with Alpha Alumina

A general rule when selecting a polishing cloth for intermediate polishing is that a hard, napless cloth will have faster polishing rates but tends to produce a more severely damaged surface. Consequently, "softer" polishing cloths like wools, felts, and artificial silks and satins—which are typically napped or flocked—are best suited with alumina.

Laboratories that use alumina polishing as an intermediate polishing step will typically follow a two-step approach—polish first with a 3-micron alpha alumina followed by a 1-micron alpha alumina on a long nap cloth. After the 3-micron polish, the surface finish is adequate for purposes like checking case depth, determining grain size, or getting a basic idea of the microstructure.

Oftentimes, labs will choose to use alpha alumina for intermediate polishing under the premise that it is less costly than using diamond polishing compounds. However, it can actually be more expensive in the long run. With alumina polishing, the wheel must be cleaned of alumina during times of non-use to avoid agglomerates forming. But with diamond polishing, once a polishing cloth is impregnated with a diamond polishing compound, its character does not change.

Intermediate Polishing with Diamond

By far, the most popular intermediate polish is diamond polishing. Unlike alumina polishing, a hard cloth should be used to ensure that the entire surface of the specimen comes in contact with the diamonds. If a medium or long nap cloth is used, the diamonds are eventually worked down into the cloth and the cloth fibers are pushed up over the particles, resulting in a loss of cutting ability. Some hard cloths include Nylon, Silk, Red Felt, Billiard, or PanW.

Diamond compounds are available with either a water or oil soluble compound, however, oil soluble compounds will last longer on a polishing cloth. When using a water-soluble compound, it's important to not use too much water during polishing as it can flush away the diamonds.

The two most commonly used abrasive sizes in diamond polishing are either 6- or 1-micron (or sometimes both). A good grind (more on this in the future!) constitutes about 90% of the effort involved in a good sample preparation, and if a good, finer grind is achieved, a 1-micron diamond compound on a red felt cloth is an excellent intermediate polish. If grinding ends with a 400 or 600-grit SiC grind, then a 6-micron diamond should be used. The 6-micron diamond will very effectively remove the scratches.

Advantages to Diamond Polishing

- More specimens can be prepared on a gram-to-gram basis
- Tendency for overpolished conditions is reduced
- Cleaner operation
- Less deformed layer
- Because hard cloths are used, they last longer

Final Polishing

Final polishing is the last step in the process after intermediate polishing. It is widely accepted that results are best obtained with 0.05-micron gamma alumina on a medium nap cloth for this step.

Other final polishing abrasives like colloidal silica, magnesium oxide, and rare earth oxides may be preferred over gamma alumina polishing at times because of their special advantages for particular applications.

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