POLISHED SAMPLE PREPARATION WITHOUT EPOXY

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Introduction: In recent years, we have received requests for meteorite sample sections to be prepared without using epoxy impregnation or mounting. The reasoning for these requests ranges from potential contamination of analyses from epoxy chemical components to degradation of instrumental vacuum from epoxy outgassing (e.g., SEM, SIMS, EPMA, etc.).

An alternative approach that we employ involves preparing a 1-5 mm thick wafer of the sample and then grinding and polishing one or both sides until a desired finish is obtained. Friable and altered samples need to have higher thickness in order for polishing to be attempted. Without epoxy to hold the sample together or a glass slide for backing, the sample needs additional material to provide the necessary support structure. This process needs to be undertaken at a much slower pace than traditional thin or thick section preparation.

Fig. 1 – Buehler Isomet saw trimming a sample. *(NASA JSC)*

Sample Shape: The first step in this process is sample chip examination. The most desirable chip will be flat or have at least one flat face. The chip cannot have extensive cracks or voids as this will lead to failure during polishing. Once a chip is chosen, trimming is occasionally required to achieve a rough wafer shape. We use a Buehler Isomet saw fitted with a single saddle vise for this purpose. This cutting must be performed at low speed with a straight blade and as little cutting pressure as possible. We use 190 proof ethyl alcohol as a cutting lubricant/coolant.

Once the rough wafer is cut, we then clean it in an ultrasonic bath with 200 proof ethyl alcohol for less than ten seconds. We use this cleaning step in-between all grinding and polishing steps as well.

The following is the procedure that we use in the Meteorite Thin Section Lab at NASA Johnson Space Center for preparing polished unimpregnated meteorite samples. As with traditional sectioning of other samples, this process requires a great deal of patience and sound judgment. In addition, experience with the grinding and polishing behavior of various sample types is critical for success. [1][2]

Both sides of the rough-cut wafer need to be ground with silica carbide lapping film in order to make them parallel, flat, and suitable for polishing. The lapping film must be blown clean with dry compressed air to remove any loose grit. We typically start with 320 grit lapping film and progress through 400 and then 600 grit film. This is done on a Buehler lapping wheel at speeds in the 40-80 rpm realm. Achondrites that are not heavily weathered seem to tolerate the higher lap wheel speeds well. Carbonaceous chondrite samples, on the other hand, may require hand lapping without the powered lap wheel.

Fig. 2 – Powered lap wheel vs hand lapping. *(NASA JSC)*

Polishing with Patience: Unimpregnated sample wafers can be polished with a variety of polishing media depending on what the researcher requires. Diamond paste is considered to be a contaminant in some cases as is alumina powder, so we take this into consideration before beginning. We have dry monocrystalline diamond powder that works well as an alternative to diamond paste. Whichever media we use is applied to a sheet of 100% cotton polishing paper that is mounted to the lap wheel. Prior to applying the polishing media, the polishing paper is blown clean with the dry compressed air just as the lapping film was above.

We progress through 6 micron polishing media and then to 3 micron and 1 micron. When using the dry diamond and alumina powders, small amounts of 190 proof ethyl alcohol can be added to the lap surface to lubricate the sample. Avoid using too much, however, as this will weaken and tear the polishing paper. When using the rotating lap, move the sample in a counterclockwise motion around the wheel while keeping it flat on the paper. Lap speed should be kept to 40-80 rpm as with the grinding procedure above. Again, consider the sample hardness and condition when selecting speed and pressure. If crumbs of sample start falling off while polishing, the best course of action is to stop everything and prepare a new sheet of polishing paper. If a crumb remains on the wheel it will only damage the sample further each time it makes a revolution.

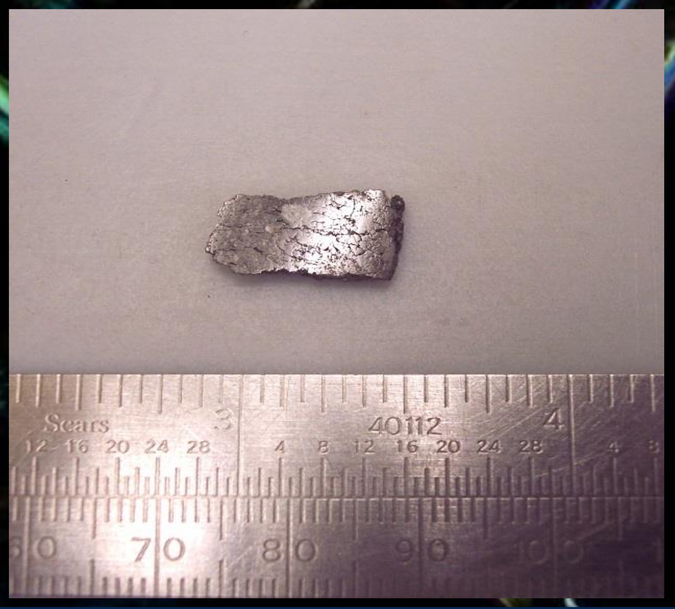

Fig.3 – MAC 88 105 ,182 polished wafer. (*NASA JSC)*

Finished Product: Once the sample is optically flat and the desired scratch-free polish is achieved, it is given a final ultrasonic cleaning in 200 proof ethyl alcohol. The sample is then carefully removed from the alcohol and blotted dry with a lint-free clean room grade wipe.

References: [1] Harrington, R. and Righter, K. (2013) Carbonaceous Chondrite Thin Section Preparation. In *Lunar and Planetary Science XLIV, Abstract #2206. Lunar and Planetary Institute, Houston.* [2] Harrington, R. and Righter, K. (2014) Ureilite Thin Section Preparation. In *Lunar and Planetary Science XLV, Abstract #1103. Lunar and Planetary Institute, Houston.*