SUMNotes

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"HOT CELL" METALLOGRAPHIC SAMPLE PREPARATION?!

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EXECUTIVE SUMMARY

Hot cells are shielded nuclear radiation containment chamber/vessels. The term 'hot' refers to the radioactivity of the materials/substances being handled in these chambers. Hot cells are common in nuclear-energy and nuclear-medicines industries and are necessary to protect individuals from radioactivity by allowing remote handling of materials via manipulators whilst observing the processes through a shielded glass window, Figure 1.

Figure 1 shows a "Hot cell" chamber with IsoMet Low Speed saw and MiniMet 1000. External manipulators are used for holding, clamping and transfer of samples between equipment [1]

Space and material waste are both critical considerations in hot cell preparation. The Minimet uses up to 85% less consumables than standard benchtop machines, greatly reducing disposal costs. In addition, the footprint is significantly smaller allowing vastly improved utilisation of space. Buehler offers equipment that can be adapted to and used in "hot cells" for nuclear radiated material metallographic preparation.

Sectioning on IsoMet Low Speed Saw

An IsoMet low Speed Saw is a precision sectioning saw designed for cutting all types of materials with little or no deformation. Its low kerf loss capability during sectioning, and great versatility attributed to a number clamping accessories for holding all types of sample shapes and configurations gives the IsoMet low speed saw the capability to cut virtually any material.

Waste generation is greatly minimised during sectioning due to minimal kerf loss as well as offering better control on the amount of lubricant/coolant used in the reservoir, which endears the machine to "hot cell" applications. Furthermore, the relatively low speeds (0-300 rpm) and application specific continuous rim diamond blades, the IsoMet low speed saw achieves an as cut surface which is generally free of damage and distortion. After sectioning, the samples are then mounted on a modified SimpliMet mounting press before grinding and polishing stages on a MiniMet 1000. The mounting press modification involves isolating the electrical/electronic components leaving a mechanical contraption that can be fitted in a "hot cell" environment.

Grinding/Polishing on MiniMet 1000

The MiniMet 1000 grinder polisher is a sample preparation system that quickly prepares materials for cross-sectional analysis. Its space saving design employs a patented geometric action that combines the advantages of hand-lapping as well as mechanical polishing. This motion provides a random polishing action, eliminating any induced polishing artefacts.

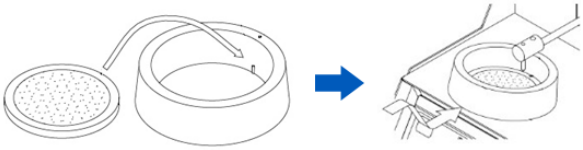
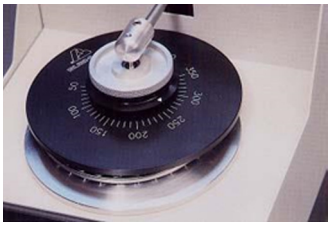


Figure 2 shows glass platen, polishing bowl and how its fitted in the machine on the right

Figure 2 shows the glass platen on which the SiC grinding papers and polishing cloths are attached as well as the polishing bowl. They both illustrate the space saving and minimal waste generation aspects during grinding/polishing stages.

The MiniMet 1000 adjustable speed and high pressure capability reduces preparation time and makes it easy to prepare various material types such as advanced ceramics, composites, and even large hardened steel sections.

Transmission electron microscope (TEM) sample preparation



For the preparation of Transmission electron microscope, The MiniMet 1000 can also be fitted with a precision thinning device, Figure 3, that grinds down a punched 3mm diameter disc of approximately 500µm thick to a desired thickness. Each index division on the thinning device is equal to 10µm allowing precise 10micron material removal rate as the thinning device rotates during a preparation cycle with a visual dial indicator of progress during grinding.

The ideal thickness for TEM thinning devices is around 100-150µm thick without showing grinding induced deformation. The grinding steps are typically done using either a 30µm or 15µm diamond grinding disc depending on the desired speed of material removal and the surface finish ideal for polishing steps. Using a precision thinning device on a carbon steel sample, a thickness of approximately 70µm thick using 15um diamond grinding disc was achieved as shown in Figure 3. Furthermore, polishing steps can also be carried out on the thinning device by attaching polishing cloths onto a glass slide. Given that the MiniMet 1000 can be set to run for a set applied force and time, a typical SumMet method can be followed for any material to a desired surface finish for analysis.

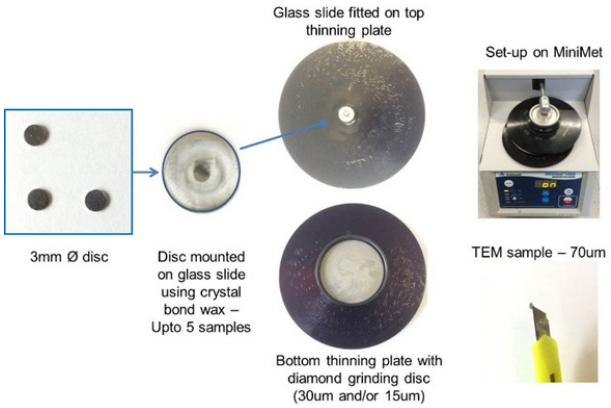


Figure 3 Showing a precision thinning attachment is used to thin a 3mm diameter disc from a thickness of 500µm to 70µm thick

Typical procedure for a carbon stell on a precision thinning device.

	Surface	Abrasive Type	Lubricant	Time (min:sec)	Force	Speed
Grinding	Diamond Grinding disc	15µm	Water	Till Planar	4lb	30rpm
Sample Integrity Stage	VerduTex	MetaDi Supreme 6µm	MetaDi Fluid	4:00.	4lb	30rpm
	VerduTex	MetaDi Supreme 1µm	MetaDi Fluid	3:00	4lb	30rpm
Final Polishing Stage	TexMet C	MasterPrep/ MasterMet	-/-	2:30	2lb	30rpm

NB: Cleaning between stages is necessary to avoid cross contamination for the different diamond grit used and after final polishing. For materials that are sensitive to water during grinding or water containing suspensions, oil based suspensions or mixtures of ethylene glycol based suspension can be adopted.

SUMMARY

The above article highlights alternative but ingenious ways of maximising use of the premium space available in "Hot cells" and the available sample preparation equipment to match this requirement.

The use of the IsoMet Low Speed saw with its advantage of generating less material waste by minimising kerf loss as thin diamond blades are used for sectioning and with a smaller coolant bath, means less coolant waste is generated for disposal. The remnant coolant can also be evaporated for water based coolants to leave dry swarf residue. Oil based suspensions can be re-used for similar types of materials being sectioned and generating similar type of contaminants.

For grinding and polishing stages, the MiniMet 1000 with its small platen and polishing bowls makes them ideal for "hot cell" areas of application due to the resultant excellent ground and polished surfaces ideal for routine or in-depth metallurgical investigations combined with extremely low consumable volumes.

Reference

1. Image taken at UK Atomic Energy Authority, Culham Science Center, UK
2. Buehler® SumMet™ - The Sum of Our Experience – A Guide to Materials Preparation & Analysis, © 2007. Buehler, a division of Illinois Tool Works Inc

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