The Annular Cutting of Important Samples for Microscopy

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A precision sectioning method is described in which the diamond blade used is specifically mounted at high tension, with the sample being fed into the blade at its inner annulus. The sawing action which results is characterized by low kerf losses, the possibility for thin slices, good surface finish, high straightness, high reproducibility and low damage. Applications which benefit from the method are mentioned, namely in the sample preparation of semiconductor, geological, composite, hard tissue and polymeric samples, as well as most non-biological samples for many areas of microscopy.

Operating Principles

The annular cutting method uses a specially-made annular (i.d.) diamond saw blade, which consists of a circular, thin, metal foil. The edge of a central hole in the blade is coated with electro-deposited diamond. The blade is clamped around its outer edge and uniformly stretched over the lip of a precision-made chuck to make it stiff. The annular blade is an alternative to the peripheral (o.d.) diamond saw blade, which consists of a circular disc with its outer edge coated with diamond. Both Cutting modes are shown in **Figure A**, in a schematic of the typical features of a precision saw, i.e. the blade, the counter-balanced work arm and loading mechanism.

Benefits of the Annular Mode

Whereas control of *'blade wander'* with a peripheral blade is largely dependent on the inherent rigidity of the blade itself (blades need to be thick to be rigid, producing higher kerf losses), the use of cheek plates (which reduce depth of cut possible) and sample loading, with the annular mode the effects of the first two criteria are effectively eliminated;[1,2] i.e. the blade's rigidity is very high due to its mounting procedure and cheek plates are unnecessary.

Further, the benefits of the method can be summarized as follows :

Reduced Cutting Losses. With any blade cutting method, the width of the slot produced during cutting depends on the thickness of the blade PLUS any lateral (sideways) deflection of the blade as the cutting load is applied. Since the annular blade is thin and has virtually zero lateral movement, cutting losses are minimized. This means that a larger amount of information (i.e. a larger number of slices) can be attained by the microscopist on scarce, unique or expensive samples. For example, the cutting of a 25mm long sample into 0.1mm slices would allow approximately 100 slices to be gained from an annular blade compared with only 35 from a typical electro-metallic peripheral blade.[2]

Higher quality surfaces. Because the sideways blade movement is practically zero, the surface produced is more flat and straight, having little bow.

Less Damage. The absence of sideways movement reduces the damage caused by sawing. This is important in cutting single crystal materials[1], composite structures and geological samples containing sometimes several phases.

Savings in Further Processing. The thinner, more precisely-toleranced slices available with the method can reduce lapping and polishing times considerably, in turn producing faster overall sample preparation times and higher *'up time'* under the microscope.

Applications of Annular Cutting

The uses of the annular sawing method have been documented in many, sometimes unrelated, areas of sample preparation for microscopy. Annular sawing, for instance, provides the dental researcher with thin sections for transmitted light optical microscopy, the electron microscopist with a representative starting point for final thinning, the electronics engineer with accurately sectioned PCB's for light microscopy, the pathologist with a 'macrotome' for calcified or undelcalcified bone and the geologist[1,3] with a sectioned sample containing no 'pull-outs' ready for lapping and polishing.

The development of the method for specific semiconductor and electro-optic research, by Fynn and Powell,[1] has led to its widespread use in Physics[1], Materials Science[1,3] and Geology.[1,3] In biological research applications, the *'Microslicing'* method has been extensively used and discussed by Professor Leslie Michaels in sectioning of otological samples requiring the benefits given by a low loss, low damage, sectioning method.[4,5]

Other applications which lend well to the annular cutting method are polymeric materials, an example being contact lens blanks (sectioned for Q.A. tests), and the precise angular low-damage sectioning of single crystal materials,[1] along with many others.

References

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4. "Ear" Chapter by Prof. L Michaels, University College London, from "Histology for Pathologists" Ed. S Sternberg, Raven Press Ltd. 2nd Edn, (1997 - in press)

5. "The Ear in the Acquired Immunodeficiency Syndrome:1. Temporal Bone Histopathologic Study" Prof. L Michaels et al, The American Journal of Otology Vol 15, No. 4 (1994)

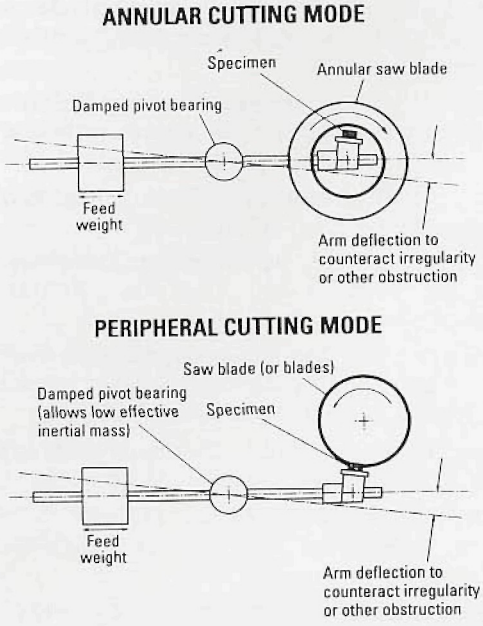
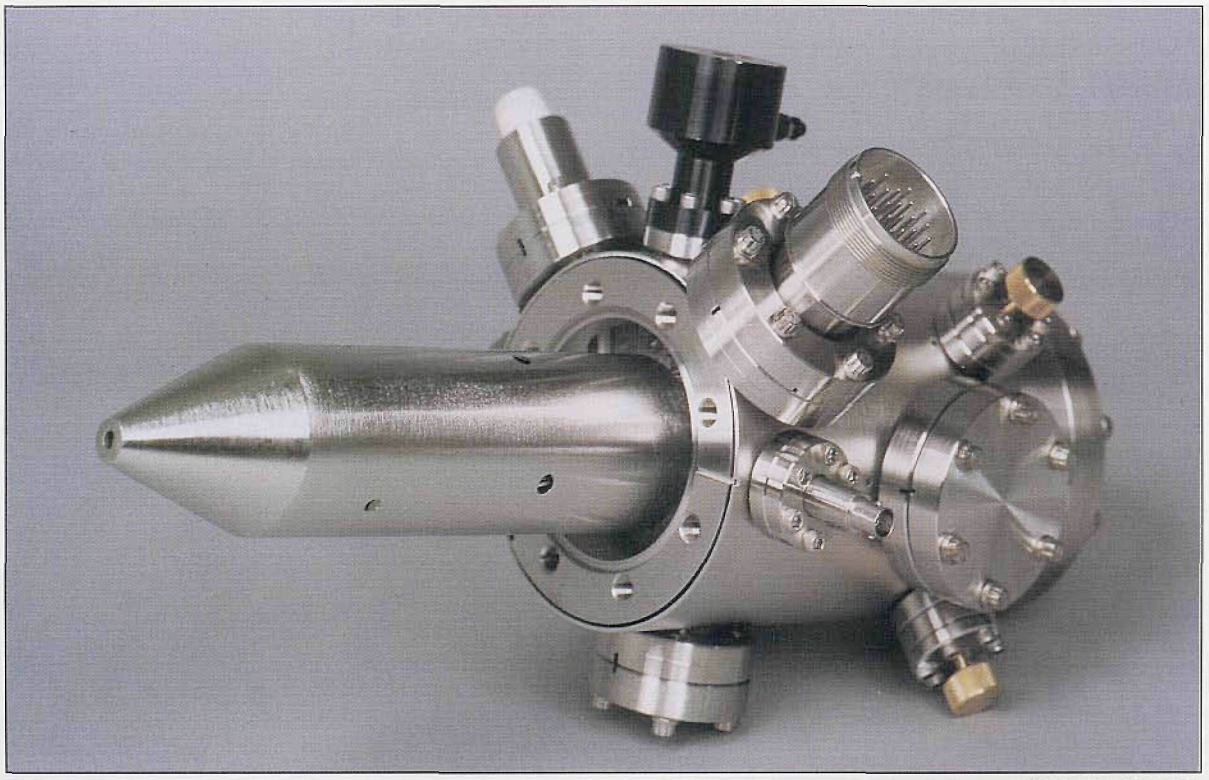


Figure A - Operating Principles of Annular and Peripheral Cutting Modes



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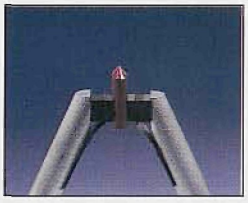

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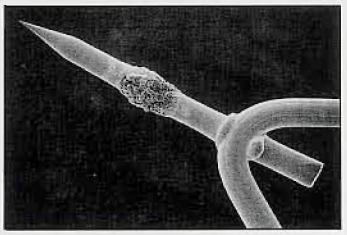

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