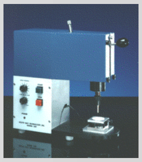


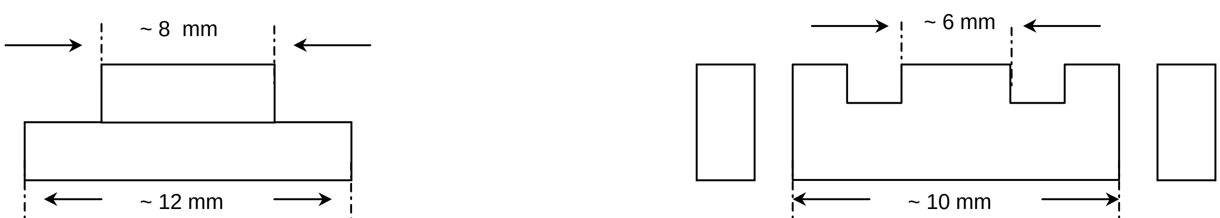
Evaluating the Precision of Abrasive Slurry Disc Cutting Techniques on GaAs

1.0: Purpose

Abrasive slurry disc cutting is commonly used as a TEM preparation tool for cutting out 3 mm discs of virtually any material type. However, the versatility of abrasive disc cutting extends beyond specimen preparation for electron microscopy evaluation. In this report, investigation of the possibility of machining small cathodes from GaAs wafers will be examined. Determination of cutting planarity, diameter variation, and surface chipping will be done to report the feasibility of machining small GaAs cathodes using the Model 360 Abrasive Slurry Disc Cutter.

2.0: Experiments

To evaluate the possibility of machining small cathodes from GaAs material, examination of a technique for preparing these structures using a Model 360 was carried out. The cathodes will be basically two circular cuts, one of a larger diameter all the way through and another of smaller diameter contained within the larger outer diameter. The tool for the ID cut must have a wider base to create the large shoulder structure. The inner cut will be only a partial cut, with the critical parameters being how eccentric to the outer diameter the cut is and how planar the bottom of the cut is. Below is a simple schematic of the proposed cathode and the test sample which was cut to evaluate circularity, planarity, and edge chipping.



A **B**

Figure 1: Cross sectional schematic view of the desired shape and test shapes created to evaluate the possibility of using abrasive slurry cutting as a means of creating specific shapes from GaAs. In A) The desired dimensions and shape of the cathode. The flat area extending past the 8 mm ID should be planar with no variation. In B) the method used for measuring the various parameters which are critical in making these structures. Measurements were taken at the bottom of the 6mm diameter structure, and the width of both circular cuts was measured as well. This was done because the proper tool sizes did not exist at that time.

The GaAs specimens were mounted to the mounting block using a low melting point wax (MWH 135) with a melting point of 135°C. Specimens were clamped down and allowed to cool, ensuring that a planar, thin glue line was created between the specimen and the mounting block surface. This is critical in obtaining the optimum conditions for producing the evaluation structure. Following mounting, the specimen was placed onto the Model 360 stage for cutting.

Cutting Procedure

The specimen was first cut with the larger diameter tool so that centering the second cut would be much easier. A 10 mm diameter brass tool was used with a 14 µ Boron Carbide abrasive slurry. The initial cut was made to define the outer diameter of the part, and the inner cut would be centered around this cut. The second cut was made using a 8 mm diameter brass tool using the same abrasive slurry. The second cut was aligned to the first cut using a Model 36001 Alignment Microscope. The specimen can be aligned to the center of the cutting tool using this device and allows precise alignment of the specimen to the tool.

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Cutting parameters were as follows:

Speed: 7 Load: ~ 100 grams Time: Full cut: 3 min 30 sec / Partial cut: 30 sec

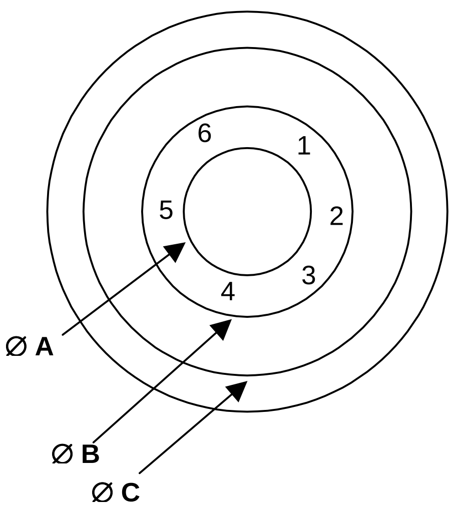
3.0: Results

GaAs is a relatively brittle semiconducting material and therefore proper selection of abrasive size and load must be done to ensure that good specimens are produced. Below is a micrograph of the specimen following the cutting operations. Note the edges of the specimen where the cutting took place is left relatively smooth. There is some noticeable chipping at the cut edges, but this can be reduced using a finer abrasive particle size.

Figure 2: OLM image of the as cut surface of GaAs following the cutting procedure. The outer diameter of the specimen was cut first, with the inner diameter cut following the first cut. The inner cut is only about 1/3 of the total thickness of the specimen which will be used for planarity measurements following the cutting procedure.

Test Measurements

To determine the efficiency of the cutting tools and process, measurements of both the actual diameters produced during the cutting and the parallelism of the center of the cut were taken. This was done to verigy whether or not this process would be suitable for producing these devices. A schematic view of the cut specimen is shown below to illustrate the various points of measurement used to evaluate the cutting efficiency. The data points collected are shown in the table.



Location	Measurement (inches)	Measurement (microns)
1	0.0145”	368
2	0.0146”	370
3	0.0146”	370
4	0.0143”	363
5	0.0144”	365
6	0.0146”	370
∅ A	0.1953”	4960
∅ B	0.2403”	6103
∅ C	0.35145”	8926

4.0: Conclusion

It has been shown that abrasive slurry disc cutting techniques can be used for specific applications other than TEM specimen preparation. Cutting tool efficiency and performance appeared to be highly uniform for critical parameters such as flatness of the cut, tool diameter and cutting speed. Cutting of GaAs with minimum damage is also shown to be possible using the Model 360.

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