Cutting Various Composite Materials for Microscopic Inspection

1.0: Purpose

Cutting and sectioning of highly composite materials containing different interfacial regions is a common problem in microscopy. Often times interfaces are key to understanding the materials properties of composites and requires careful preparation techniques. Certain factors must be considered when cutting a specimen for inspection, namely the amount of damage, smearing effects between layers, and the smoothness of the resulting cut surface. The use of low speed diamond wheel sawing techniques generally produces relatively smooth cuts with little smearing and damage to the subsurface structure. Further processing steps such as grinding and polishing should also be minimized to reduce preparation time. This report describes results obtained from cuts made on composite materials containing rubber, metal fibers, and other materials. Optical light microscopy was done on the samples to show the delineation of the interfaces compared to the as-cut surfaces produced from a coarse cutting machine.

2.0: Experiments and Procedures

Several samples of composite materials were obtained for cutting experimentation. Materials ranging from rubber composites to metals were cut using the Model 660 Low Speed Diamond Wheel Saw. The materials are shown below, demonstrating a wide range of samples used in the tests.

Figure 1: Image showing the various samples cut using the Model 660 Low Speed Diamond Wheel Saw. Materials ranging from rubber, metal rubber composites, encapsulated samples, and metals were all cut using the Model 660.

All samples were cut using a Model 660 Low Speed Diamond Wheel Saw and were cut with a 5" diamond wheel. Samples 1, 4, 5, and 6 all were mounted using standard graphite/aluminum mounting plates and immersed in a low melting point wax (MWH 135). The mounting plates were then placed into the Model 66001 Single Axis Goniometer and were oriented in the desired orientation for cutting. Sample 2 was mounted onto a Model 66007 Right Angle Holder using the same low melting point wax. Sample 3 was mounted onto a Model 66006 Vise Holder and cut in the same fashion. Following the mounting process, the samples were cut using the DWH 5152 (High concentration, medium diamond size) diamond wheel. Various parameters were used for the cutting operations and are described in the following chart.

Sample #	Wheel Speed	Load (grams)	Cutting Time (minutes)
1	10	800	135
2	10	300	13
3	10	600	27
4	10	600	120
5	10	350	270
6	10	800	17

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3.0: Results

Several images of different samples were taken following the cutting process to illustrate the difference in observable surface structure before cutting with the Model 660 and after cutting. Figure 2 below shows Sample 1 both prior to and following cutting on the Model 660.

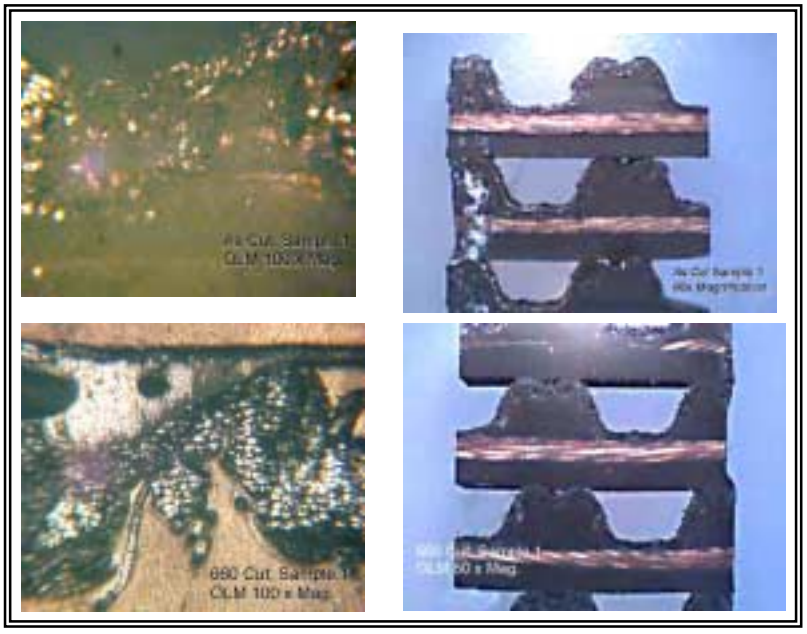

Figure 2: Images showing Sample 1 both prior to and following the cutting process on the Model 660 Low Speed Diamond Wheel Saw. The images at the top show the as-cut surface prior to cutting on the Model 660. Interface quality and delineation of the structure is obscured due to the poor cutting quality. The images below show the surface quality following cutting on the Model 660. The sub-surface structure is clearly visible and the interface regions are clearly delineated.

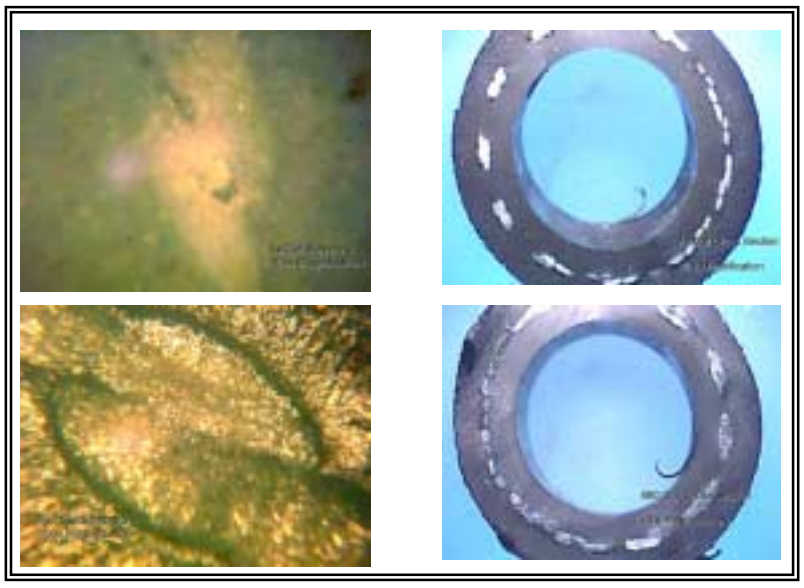

Figure 3: Images showing Sample 3 both prior to and following the cutting process on the Model 660 Low Speed Diamond Wheel Saw. The images at the top show the as-cut surface prior to cutting on the Model 660. Interface quality and delineation of the subsurface structure is poor in the reflected light micrograph (upper left). The images below show the surface quality following cutting on the Model 660. Subsurface structure is clearly visible in the reflected light micrograph.

4.0: Conclusions

It has been demonstrated that cutting using a low speed diamond wheel saw can greatly enhance the ability of subsurface structures to be imaged directly following the cutting process. This ability of the Model 660 greatly reduces the amount of time required for polishing operations and helps minimize specimen preparation times.

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