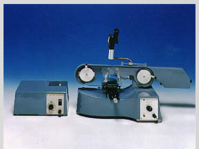
Model 850



Cutting Highly Different Hardness Materials for Adhesion Analysis

Applications Laboratory
Report 16

Cutting and Sectioning

1.0: Purpose

To cut a metal / adhesive / metal composite material to investigate the adhesion interface between the metal and the adhesive layer. These types of materials exhibit large differences both in hardness and cutting characteristics, making them a difficult material to section without inducing damage such as smearing, tearing, and poor overall quality of the interfacial region. This report outlines the techniques used for sectioning difficult materials such as these using a Model 850 Wire Saw. The Wire Saw has the advantage of gentle cutting action combined with precision, allowing difficult specimens to be prepared with relative ease and turnaround. Evaluation of the cutting parameters necessary for successful preparation of these types of materials will done to improve on existing preparation procedures for these types of materials.

2.0: Experiments and Procedures

Four specimens of the composite material were sent pre-marked for identification. Each specimen was constructed of a stainless steel top and bottom plate adhered together with a soft, rubber type epoxy which bonded the two pieces together. The following diagram and schematic show the dimensions of the specimen and their designation.

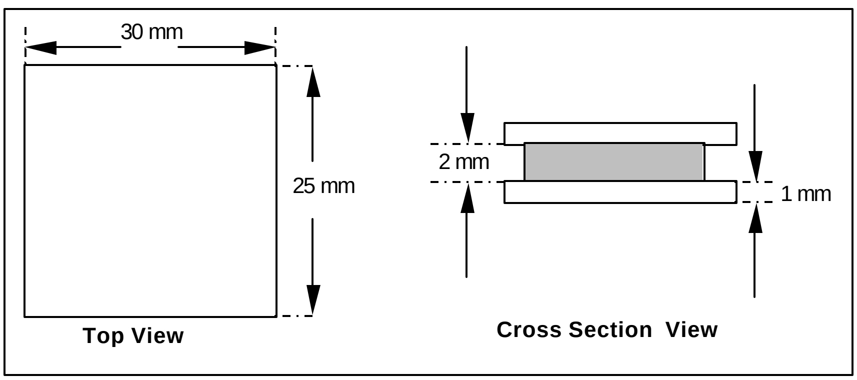


Figure 1: Schematic illustration of the specimens to be sectioned. The primary interest is the interface between the adhesive (gray area) and the stainless steel plates. Wire sawing will be used to preserve the interface region during cutting and to reduce any lapping and polishing steps to a minimum.

Each specimen was mounted onto the mounting blocks of the Model 850 Wire Saw using low melting point wax. The integrity of the adhesive layer during preparation was a big consideration, so a wax with a melting point of around 70°C was used to prevent any adverse effects caused by heat or solvent. Next, the parts were sectioned using a Model 850 Wire Saw with a Model 85030 Slurry Recirculating System. Three different parts were cut to find the optimum conditions for cutting these composite materials, all of which are discussed in the Results section.

Specimen Cutting

The following parameters were used during the cutting operation:

Slurry: 23 μ Boron Carbide abrasive   Load: 10 notch;   Speed: 4 on dial   Wire: 0.015” stainless steel

During cutting, wire failures became a problem, with two of them failing before a completely successful cut could be made. The metals which the wire comes into contact with all cut more or less by ductile shear formation. Small pieces of the metal material are sheared from the specimen, causing the blade to bind up on these small ductile shear chips. Eventually, a large enough shear formation comes in contact with a weak portion of the wire and causes the wire to fail. This problem is attributed in part to the large surface area of the specimen being cut, with large surface area of metal causing possible binding problems due to the nature in which metals cut. Below is a schematic diagram of the cutting process.

SBT SOUTH BAY TECHNOLOGY INC.
1120 Via Callejon ■ San Clemente ■ California ■ 92672
Telephone (714) 492-2600 ■ FAX (714) 492-1499 ■ Telex 311882

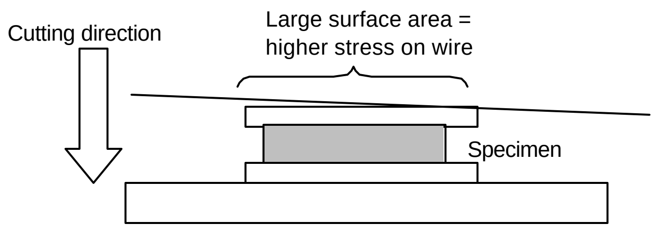


Figure 2: Illustration of the cutting process, showing the effect of surface area on the wire. In this configuration the wire is in constant contact with a large surface area of metal, causing stress and friction between the two, ultimately leading to wire failure.

To alleviate this problem, the surface area of the specimen can be reduced, either by cutting the specimen into smaller sections or by mounting the specimen in a different manner. In this case, the specimens were mounted vertically so that the metal portions of the specimen contacted the wire only by their thickness, and not the total width. This resulted in a drastic reduction of the area being cut by the wire, enabling straighter and more efficient cuts than before. When the specimens were mounted in this manner, cutting times were reduced by more than half and no wire blade failures occurred after cutting them in this manner. Below is a schematic illustrating the setup used for cutting.

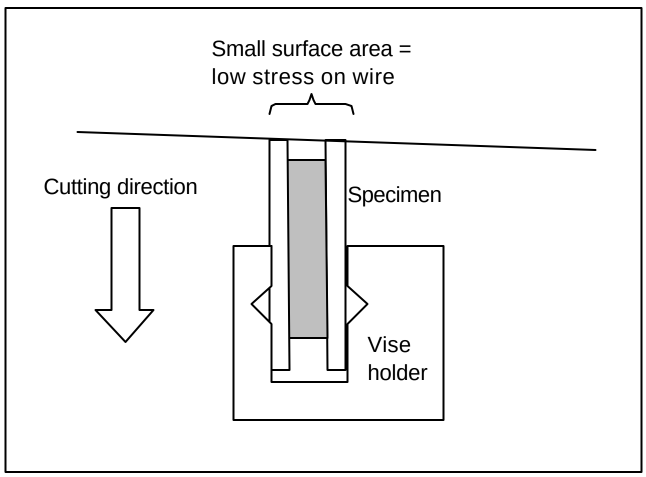


Figure 3: Illustration of the more efficient method for cutting these composite materials. By orienting the specimen vertically, the smallest possible cross sectional area was presented to the wire blade, which in turn reduced the friction on the wire and allowed sectioning of the device with precision. This method also produces straighter cuts due to increased support on both sides of the wire blade during cutting.

3.0: Results

Cutting composite materials with low damage and maintaining a straight, flat cut is imperative for interfacial evaluation. The cut must be uniform and prevent any deformation from occurring during the cutting process. This experiment has shown the problems associated with cutting composite materials and has demonstrated specific methods which can help achieve the required cut for these materials. Using wire sawing techniques and proper specimen mounting, good cuts can be obtained of highly composite materials such as these.

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1120 Via Callejon ▪ San Clemente ▪ California ▪ 92672
Telephone (714) 492-2600 ▪ FAX (714) 492-1499 ▪ Telex 311882