I. Objective

This report presents the results of a preliminary study on the microstructure of the ultrasonically welded aluminum. It includes the results of optical microscopy, focused ion beam microscopy (FIB) and transmission electron microscopy.

II. Material

The specimens that were used in this study were provided by Ford Scientific Research Labs. They consisted of ultrasonically welded coupons of AA6111-T4 aluminum alloy. The coupons consisted of strips with 25.4 mm width and 0.9 mm thickness. The coupons were welded using an ultrasonic welding machine at a frequency of 20 kHz and an energy level of 400 J. The cross section of the specimen is parallel to the vibration direction. The ultrasonically welded samples were mounted in epoxy and polished to a fine finish at Ford Scientific Research Labs.

III. Experimental Procedure

At Princeton University the samples were etched for about 5-10 s in a solution that consisted of 45 ml hot tap water, 4 ml H₂SO₄, and 1 ml HF. Optical microscopy were performed using an inverted microscope. A consecutive series of overlapping optical pictures were taken to image the whole welded interface of the samples. These pictures were later scanned and pieced together in the same order they were shot to form a single panoramic image revealing the whole weld line. The reason for this picture montage was multi-faceted. On one hand it would help identify periodic features in the interface that would scale with the macroscopic test parameters such as ridges and grooves of the mechanical grips. On the other hand, it would identify differences in the microstructure at the center of the weld as opposed to the edges of the weld where thermal and mechanical forces would be different. Another benefit of panoramic view would be to see the change in the morphology and orientation of the welded or intact interface segments with distance from the edge. As an example, it would show possible