

Nano-EDM Utilizing Etched Tungsten Nanoprobes & Modulated Electrical Fields

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Sponsors: University of Kentucky Precision Systems Laboratory

Objectives: Utilize electrochemically etched tungsten electrode to EDM nanometer sized structures through the modulation of an electrical field.

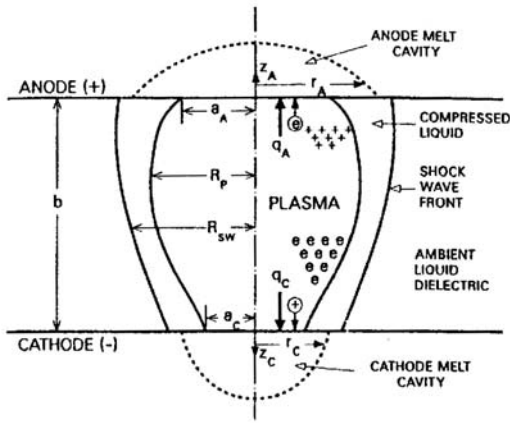


Figure 1. Breakdown of electrical field during EDM process

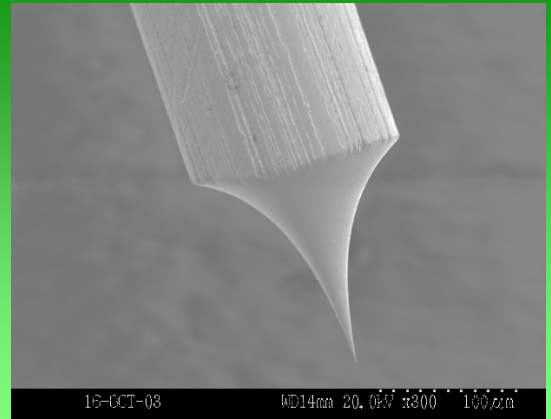


Figure 2. Sample etched tungsten electrode

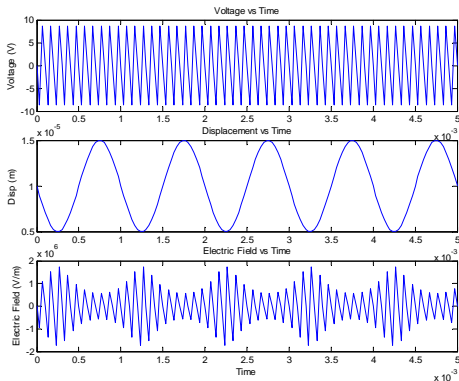


Figure 3. Method of modulating electrical field

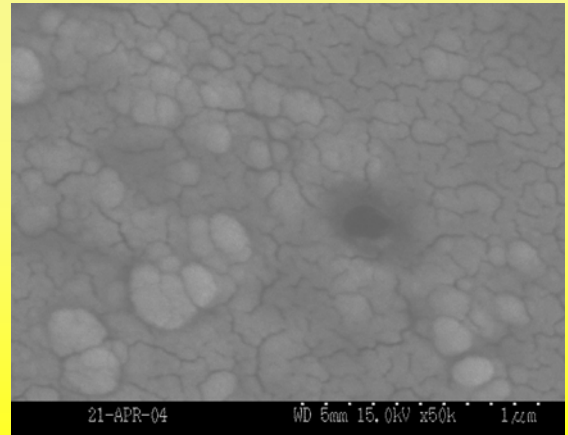


Figure 4. Feature resulting from early experiments

Project Summary: Electrical discharge machining is a versatile machining option that is well suited for the world of micro & nano-machining. The benefits of non-contact machining allow for increasingly small tool geometries to be used, and solidifies the feasibility of machining nanometer sized structures. There exist certain challenges in adapting the EDM process and the capabilities of conventional electrical discharge machines to accommodate the conditions and control requirements necessary to successfully machine sub micron features. **Figure 1** illustrates the plasma column that builds between the cathode and anode during the EDM process. The energy density is very high within the column, melting a pool on the electrode and work piece. The plasma and vapor column collapses after discharge, exploding molten material into the fluid while some re-solidifies on surfaces. **Figure 2** is an SEM image of an electrochemically etched tungsten electrode that is used for this process. To accommodate sub micron scale features, the discharge energy must be very small. **Figure 3** depicts the method of modulating the electric field to control discharge energy. The gap distance is modulated through piezoelectric actuation, while the voltage is modulated through the EDM circuit. The SEM image in **Figure 4** shows a resulting feature from early experiments on a gold work piece using only displacement modulation.

