"simplicity" of this picture involves relating the microscopic physics to the semi-classical limit involving how light interacts with matter. Here, the underlying idea that coherent oscillations of charge that Giuliano Preparata suggested could be important, in the long-wave limit, in the associated interaction is absolutely correct. His observation about this is truly important.

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Field Assisted Electroplating

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Introduction: As part of a senior class project for Chemical Engineers at UCSD, experiments on field assisted electroplating were conducted for both copper and Pd/D electrodeposition. Copper electroplating, both in the absence and presence of either an electric or magnetic field, was tested prior to conducting Pd/D electrodeposition. For the purposes of this project, the copper electroplating served as a control study to interpret and gain a better understanding on the effect of an external field on electroplating. The Pd/D codeposition experiments were set up to be replications of the LENR experiments conducted by SPAWAR Systems Center San Diego in hopes of attaining similar results.

Experiments: In the copper electrodeposition experiments, the effects of the electrolyte composition, the electrolyte pH, and application of an external field were examined to adjust the plating process, the electroplating efficiency, and the surface morphology of the deposit. The pH of the electrolyte solution was controlled to ensure that cupric ions were plentiful for optimal copper plating. The electrolyte solution was sparged with nitrogen gas to displace dissolved carbon dioxide and oxygen gases and prevent the formation of carbonates on the cathode. Using a range of pH from 0.5 to 3, plating efficiencies ranged from 90–95% and did not result in a dramatic correlation between pH and plating efficiency. When Cu is plated out onto a Ag cathode from a 0.5 M copper sulfate solution in the absence of an external field, the resulting metal deposit is smooth, Figure 1a. However, electroplating in a magnetic field resulted in a metal deposit that had a rougher surface with pits and valleys, Figure 1b. The Lorentz forces of the magnetic field were positioned tangentially to the electric field, and caused a gradient in the electrolyte concentration near the cathode. This gradient encourages fractals to grow on the surface of the deposit. No effect on the surface morphology of the Cu deposit was observed when electroplating was conducted in the presence of an external electric field (Dini, 1993).

In the Pd/D electrodeposition experiments, Pd was plated out onto an Ag cathode from a $PdCl_2$-LiCl-D_2O solution. The cathode was in contact with a CR-39 solid state nuclear track detector. When traversing a plastic material such as CR-39, charged particles create along their ionization track a region that is more sensitive to chemical etching than the rest of the bulk. During chemical etching, the ionization trail left by the charged particle in the detector is dissolved away and a track remains as permanent hole or pit which can be seen with the aid of an optical microscope. The size, depth of penetration, and shape of the track provides information about the mass, charge, energy and direction of motion of the particle that created it (Nikezic & Yu, 2004). The Pd/D codeposition experiments were conducted in the presence of both external electric and magnetic fields. At the end of the experiments, the CR-39 detectors were etched in 6.5 N NaOH at 70°C for 7 hr. Microscopic examination of the CR-39 detectors shows the presence of pits in both codeposition experiments (with electric and magnetic fields). These pits occurred in areas where the cathode had been in contact

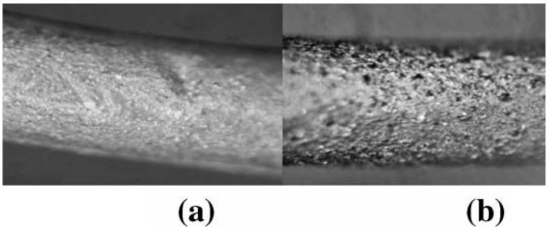

Fig. 1. Morphology of Cu electrodeposited from 0.5 M $CuSO_4$ in the (a) absence and (b) presence of an external magnetic field. The magnetic field within the cell is about 2500 Gauss.

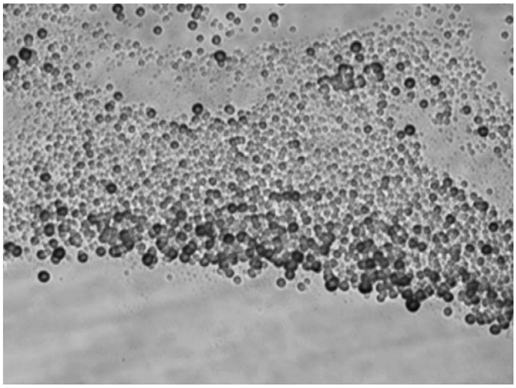

Fig. 2. ×200 magnification of a concentrated area of pits where the Ag/Pd cathode was in contact with the CR-39 detector during an external magnetic field experiment.

with the CR-39 detector. Figure 2 shows an image of the pits obtained at ×200 magnification. Several concentrated areas of dark pits are observed.

When focusing deeper inside these black pits, bright spots are observed that are due to the bottom tip of the conical track (Nikezic & Yu, 2004). The optical contrast, shape, and bright spot in the center of the pit are used to differentiate between real particle tracks (which tend to be dark) from false events (which are often lighter in appearance and irregular in shape) (Abdel-Moneim & Abdel-Naby, 2003; Ho et al., 2003). In Figure 3a mottled areas in the plastic are observed near the outer edges. The mottled areas show no contrast, and the shapes are irregular. These features are consistent with chemical damage. In Figure 3a, toward the center, more defined pits are visible. An arrow in Figure 3a indicates what appears to be a triple pit. Figure 3b shows an image of this triple pit at magnification ×1000. Possible explanations for the formation of a triple track are (i) that it is due to overlapping single tracks or (ii) it is the result of reactions that emit three particles of similar mass and energy. Focusing inside the triple pit to examine the bottom of the pit, Figure 3c, it appears that the individual lobes of the triple track are splitting apart. This favors explanation (ii) as the source of this triple pit. Such triple pits have been shown to form when CR-39 is bombarded with energetic neutrons (Abdel-Moneim & Abdel-Naby, 2003). The main constituent of CR-39 is ^{12}C (32% by weight). A neutron can briefly form a metastable ^{13}C then shatter into three alpha particles and the residuals of the reaction can be viewed in the CR-39 detector as a three-prong star similar to those shown in Figure 3b (Abdel-Moneim & Abdel-Naby, 2003). The deuterated water used in these experiments does contain tritium and there is prior evidence that tritium production in these cells does occur (Szpak & Mosier-Boss, 1998). One possible source of neutrons energetic enough to shatter carbon atoms is tritium-deuterium fusion.

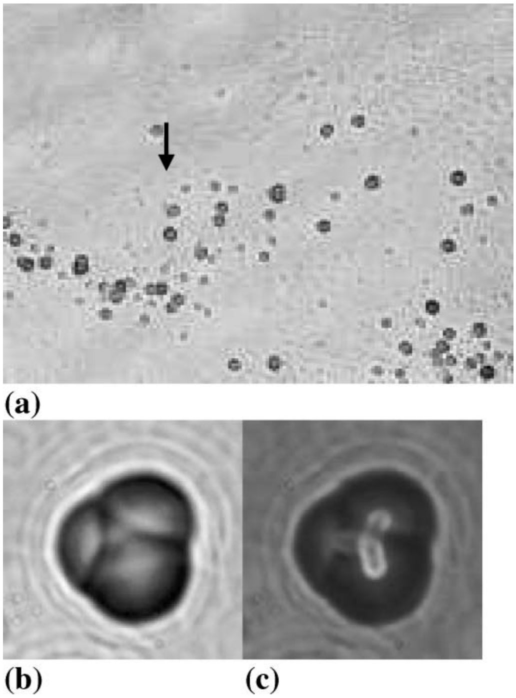

Fig. 3. (a) ×200 magnification of a cloudy area observed where the Ag/Pd cathode was in contact with the CR-39 detector during an external magnetic field experiment. Arrow indicates a "triple" pit. Images of the triple pit obtained at ×1000 magnification where (b) the focus is on the surface of the CR-39 detector and (c) the image is an overlay of two images taken at two different focal lengths (top and bottom of pit).

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