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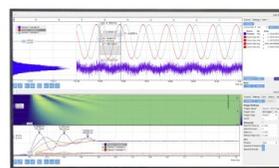
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Small-scale electrochemical cleaning of molybdenum to improve spotwelding characteristics

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Electrochemical cleaning of molybdenum immediately prior to spotwelding has been found to improve adherence of both tungsten and tantalum to molybdenum. Normally electrochemical cleaning is accomplished by immersion in a large bath. We have had excellent results cleaning a small area under a single drop of cleaning solution immediately prior to spotwelding.

Molybdenum (Mo) is a notoriously difficult metal to spotweld. Our attempts to spotweld a W-5% Re/W-26% Re thermocouple to a Mo single crystal resulted in weak and brittle spotwelds. We found that electrochemically cleaning the Mo in a 20% (by weight) aqueous sodium hydroxide (NaOH) solution with 6–8 VAC noticeably improved the spotwelding characteristics. This treatment dulls the finish of polished Mo. Since we were working with a polished single crystal, we had to devise a method which would not mar the polished face of the crystal.

Our solution was to perform the electrocleaning on a very small scale, under a single drop of 20% aqueous NaOH. The high surface tension of the aqueous NaOH effectively limits the spread of the droplet even when placed on a vertical surface. The crystal is connected to one pole of a variable transformer set to provide 6–8 VAC. The other pole of the transformer is connected through a 12-V light bulb to a small Mo electrode. The Mo electrode is touched to the meniscus of the drop of NaOH solution and current applied for several seconds. During this time, the solution foams vigorously. The electrode is moved back and forth to insure cleaning of the entire area. The light bulb is used to protect the variable transformer by providing a load to limit the current capable of being drawn. The light bulb serves as a limiting resistor to reduce the danger of damaging the transformer by touching the electrode to the metal being cleaned. Once the cleaning is

complete, the solution is left in place during the spotwelding. Care must be taken to wear protective clothing and eye protection during spotwelding to avoid burns caused by caustic solution spattered by the applied spotwelding current. By leaving

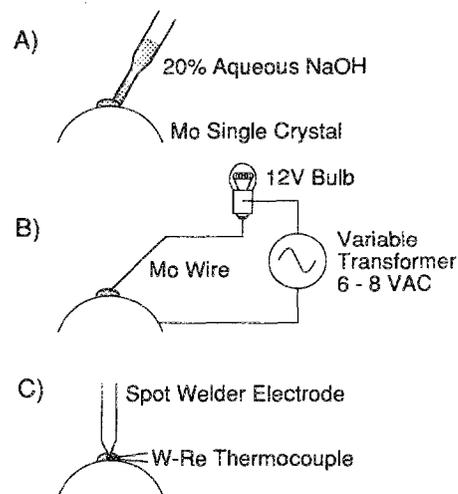


FIG. 1. The steps used to clean molybdenum to improve spotwelding: (A) application of cleaning solution; (B) application of current to electrochemically clean the surface; (C) spotwelding with the cleaning solution in place.

the cleaning solution in place, the freshly cleaned surface is maintained during spotwelding. After the spotwelding is complete, the drop of cleaning solution is removed with a pipette and the sample flushed with distilled water several times.

Samples treated in this way produced acceptable spotwelds at much lower power than uncleaned samples.

The task of attaching 0.5-mm-diam W-Re thermocouple wires to Mo, essentially impossible prior to cleaning, was accomplished with only 10 W s (~ 1.5 -ms pulse) using our technique. Similar improvement was found for spotwelding tantalum wire and foil to Mo.

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Passivated uranium as an electron-spin analyzing target

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A passivated uranium surface has been tested as an electron-spin analyzing target in a retarding potential Mott detector. The effective Sherman function and yield were measured for electron energies of 15–34 keV at energy-loss acceptance windows of 500 and 1000 eV. The figure of merit was found to be $\approx 1 \times 10^{-5}$. The uranium target had a higher Sherman function than either gold or thorium at 20-keV and 500-eV energy loss. The passivated surface is also extremely stable, thus proving to be an acceptable target for electron-spin analysis.

Electron-spin polarization detectors which operate at much lower voltages than the traditional Mott detectors have become increasingly popular recently.^{1–3} In this note we report on the performance of a medium-energy, retarding potential Mott detector with a passivated uranium surface as the analyzing target.

The detector is based on the Rice design,⁴ which utilizes a high- Z scattering target held at $V_s = 20$ –30 keV. The left-right electron scattering asymmetry is related to the spin polarization normal to the scattering plane^{5,6} by

$$P = \frac{1}{S_{\text{eff}}} \frac{I_L - I_R}{I_L + I_R}.$$

Here, the Sherman function S represents the relativistic, spin-orbit correction to the elastic cross section. The electron detectors are held at a lower voltage V_w so that the electrons are decelerated (i.e., retarded) before they are detected. Therefore, only electrons which have lost less than V_w in energy will be counted. This eliminates most multiple e^- -nucleus scattering events, since they are likely to have lost more energy than single scattering events. The larger V_w (i.e., energy-loss window), the lower the effective S .

The widely accepted criterion used to evaluate the performance of an electron-spin polarimeter is the figure of merit (FM)⁷:

$$FM = S_{\text{eff}}^2 (I/I_0).$$

The FM is purely based on counting statistics, reflecting the relative weight of S_{eff} and the backscattered yield I/I_0 when calculating the statistical uncertainty of a measured polar-

ization. The sensitivity of the detector to systematic errors from beam deflections is not included in the FM. In general, increasing the Sherman function will reduce the effect of beam deflections on a measured polarization.

Because S_{eff} increases with increasing nuclear charge of the target, uranium ($Z = 92$) was chosen as a potential electron-spin analyzer. Pure uranium, however, is chemically reactive, oxidizing within a few minutes of exposure to the atmosphere. This renders natural uranium unsuitable as a spin analyzer by reducing the yield and creating an unstable surface. Passivation of the uranium surface was achieved by following the prescription given by Allen and Holmes.⁸ A 0.178-mm-thick, 99.99% pure uranium foil was used,⁹ and the black oxide film was removed by immersion in dilute nitric acid until the foil attained the characteristic silvery white appearance of the pure metal. The foil was immediately electropolished in 1:1:1 $\text{H}_2\text{SO}_4:\text{H}_3\text{PO}_4:\text{H}_2\text{O}$ at 0.2 A/cm², rinsed with de-ionized water and ethanol, and promptly placed into a UHV chamber which was then pumped down to $\approx 10^{-10}$ Torr. The surface was cleaned by neon bombardment for 4 h from a sputter gun operating at 2 keV and a beam density of 20 $\mu\text{A}/\text{cm}^2$, and then passivated by substituting nitrogen for neon and sputtering for ≈ 1 h. The foil was removed from the chamber, mounted inside of the spin detector, and the system was again pumped down.

In order to measure S_{eff} , a spin-polarized electron beam was obtained by photoemission from a negative electron affinity GaAs(100) cathode using circularly polarized light. In order to account for any spin precession in the electron-transfer optics, all three components of the spin polarization