Pulse Electrodeposition of Natural Uranium in 2-propanol Acidic Ionic Solution

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The regular way to produce samples for alpha- and other radiation emissions spectrometry is by means of electrodeposition. Electrodeposits may also be use to fabricate irradiation targets for radiopharmaceutical production.

In this work, the electrodeposition of natural uranium was made by pulsed potential in galvanostatic state, over nickel substrate with cathodic area of 2.6 cm^2. This area was exposed to $UO_2(NO_3)_2$ solution diluted 1:20 in 2-propanol, having final concentration at 50 mmol/L [U] with pH<1. The tension pulse varied from 0 V to 9 V inside a tubular quartz electrochemical cell. The pulsed electrodeposition lasted 3600s having a rectangular wave with frequencies varying from 10 to 20 Hz. In Figure 1, it is shown a sample of this tension pulsing signal with a duty cycle of 80% with 17 Hz.

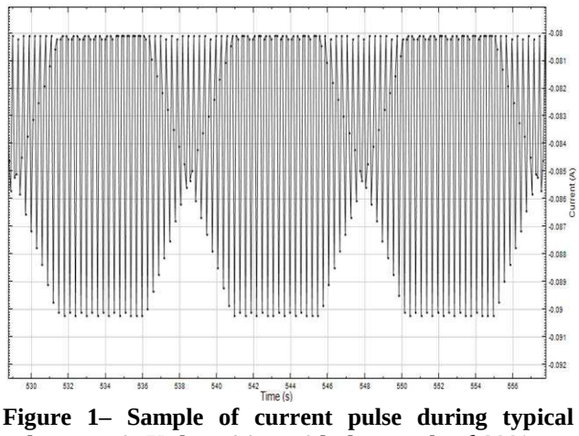

Figure 1– Sample of current pulse during typical galvanostatic U-deposition with duty cycle of 80% under frequency of 17Hz.

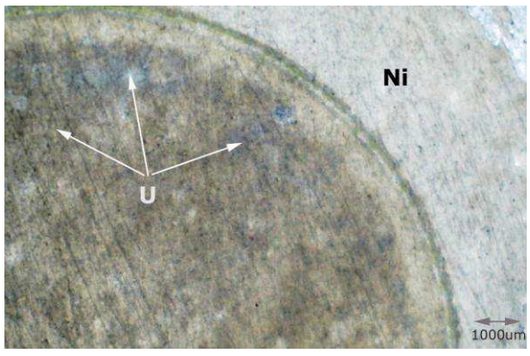

Figure 2 – General metallographic view of the uranium electrodeposit produced by pulsed tension.

In Figure 2, it is possible to see that the structure shows several colors for the deposited material, from blue to dark brown. The oxides/hydroxides of uranium vary in this range of colors depending on the layer thickness and the crystallization level.

A potential build-up of uranyl hydroxides crystals may follow this reaction:

$$2UO_2^{2+} + H_2O \rightarrow [UO_2\text{-}O\text{-}UO_2]^{2+} + 2H^+$$

$$[UO_2\text{-}O\text{-}UO_2\text{-}O\text{-}UO_2]^{2+} + 2H^+$$

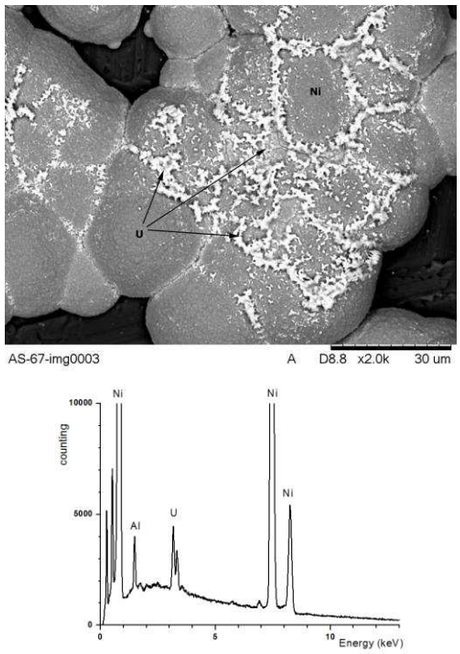

Figure 3 – SEM/EDS indicating the platelet formations of uranium pulsed potential deposits

In Figure 3, it is possible to verify that platelets of uranium deposits formed after pulsing operation. It is also clear that its formation occurred at preferential sites over the substrate. In equilibrium condition, there are several electrochemical possibilities of deposits: uranium metal, oxide or hydroxide formation, as shown in Figure 4.

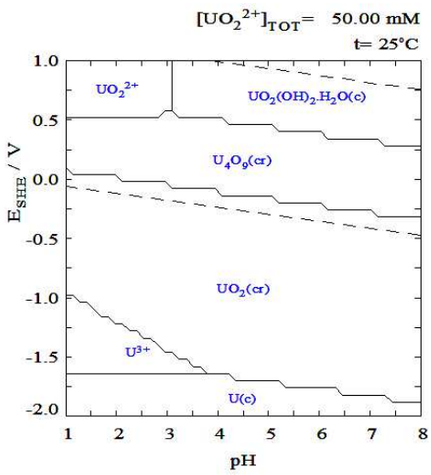

Figure 4 - Pourbaix diagram of uranyl media with 50mM [UO_2^{+2}] solution.

As a general conclusion, the pulse electrochemical technique may form in a full range of compounds produced during potential variation to keep the galvanostatic state of the pulsed process. It is believed that hydroxides, oxides and metallic uranium may have been formed in a mixed up way. The platelet structure of uranium deposition at grain boundaries may be one of characteristics of this dynamic process.