

THE NUCLEATION AND GROWTH OF SOME ELECTRODEPOSITED MATERIALS
ON GRAPHITE

BY

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As part of a continuing program of research on the electrochemical activity of graphite anodes, the nucleation and growth of electrodeposits on graphite is being studied. The anodic deposition of lead dioxide on graphite and the cathodic deposition of copper on graphite have now been investigated.

The graphite substrate consisted of spectrographic-grade graphite which was polished through 0.05 micron by conventional metallographic techniques. Anodic deposition of lead dioxide was carried out using a saturated solution of lead nitrate as the electrolyte; copper was deposited cathodically from a conventional acid copper sulfate electrolyte.

The nominal current density for all deposits was maintained constant at a sufficiently low value so as to allow the formation of crystalline facets during the growth of the deposit. Timed sequences of deposits at this constant current density (about 7 asf) were prepared for both the copper and the lead dioxide deposits. The nucleation and growth of these materials was studied by electron microscopy and optical metallography.

A rather striking morphology was observed for the copper deposits on graphite. These deposits initially consisted of localized clusters of grains which were randomly distributed over the substrate surface. As deposition proceeded, these clusters developed spire-like projections which grew out from the plane of the graphite-electrolyte interface. The sides of these spires, as well as their points of origin, exhibited well-defined crystalline facets. Complete coverage of the graphite surface was finally achieved through a combination of growth and some additional nucleation of more clusters. Not too surprisingly, this result indicates that there are certain sites which are more favorable to copper nucleation than others. These latter sites serve as nucleation sites only after the most favorable sites have been consumed.

The morphology of lead dioxide deposition on graphite is considerably different from that of copper. In this case, surface coverage occurs much more rapidly with a greater nucleation density for a given number of coulombs passed through the system than was observed for copper. While the lead dioxide deposits also exhibit crystalline facets, vertical growth of these clusters is considerably less pronounced than was observed for copper.

The hypothesis is advanced that the observed differences in the nucleation density and the manner of growth of these two deposited materials can be ascribed to the relative differences in electrical conductivity of copper, lead dioxide, and graphite.

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