

Synthesis and Characterization of Nanostructured Metal Films from Surfactant and Polymer Templates
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There is considerable interest in general methods to produce nanostructured metals for a large variety of applications such as high surface area porous electrodes, electrochemical capacitors, and as electrodes in batteries. In the mid '90s Attard and co-workers[1], and subsequently Attard, Bartlett and their co-workers[1-4] developed a methodology based on electrodeposition into a non-ionic surfactant liquid crystal template which produces arrays of highly ordered pores with diameters between 4 and 7 nm. In subsequent work this group has extended the method to electrodeposit mesoporous platinum, ruthenium, nickel, cobalt, lead oxide among other materials[5-8].

We are interested in determining if this method was a general one and if other templates would give similar results. In particular we were interested in using block co-polymers, as the phase diagrams of such materials are considerably richer and more readily controllable than that of non-ionic surfactants. A block co-polymer of polypropylene and polyoxyethylene, Pluronic P123 from BASF was used to template solutions of nickel salts. The concentration of the P123 was chosen such that the solution was expected to have a hexagonal phase. Electrodeposition from this solution onto gold electrodes gave a bright silver film. X-Ray diffraction showed this film to have a regular ordering. Cyclic voltametry showed a significant increase in surface area. These findings are consistent with the formation of a film of hexagonal pores.

Experiments with Pluronic P65 likewise gave bright silver colored films on planar gold electrodes, which XRD confirmed were ordered and cyclic voltametry again gave a significant (approximately 10 fold) increase in surface area.

We are particularly interested in formation of high surface area porous electrodes, and so we have been applying this block co-polymer templating method to 3-dimensional substrates. By warming the liquid crystal solution appropriately we were able to fill the voids in foamed nickel substrates. Electrodeposition of nickel produced an approximately forty fold increase in surface area. Because of the irregular nature of the surface of the nickel foam it is not possible to use X-ray Diffraction to establish the ordered nature of the nickel deposits.

References

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