TOPOTACTIC/TOPOCHEMICAL CONTROL IN PREPARATION OF CONDUCTING MATERIALS

Scope

The rational synthesis of conducting materials requires attention to control of structure during the preparation of these materials.

Justification

Although topotactic methods for the preparation of inorganic composites and refractory materials (e.g. epitaxial growth) has been an area of intensive research, similar strategies have not been thoroughly explored for conducting materials composed of two-dimensional conducting polymers and quasi-1-D linear chain compounds. The ability to predictably control the structure of the material of interest will allow the synthesis of conducting systems with desired electronic and structural properties.

The fundamental problem can be divided into two areas: (1) control of macroscopic morphological structures; (2) synthesis of new materials based on topochemical reactions. The major area of interest includes the use of "substrate control" in the synthesis of new materials, and the chemical and electrochemical polymerization/crystallization of materials at well-characterized, epitaxially oriented surfaces. Also included is control of morphology by the environment of the growth medium.

Research Proposal

(1) Studies to understand the relationship between ordered structures of conducting materials and the structure of their precursor. This has been exploited in some systems (e.g. covalently linked phthalocyanines and fused heterocyclic polymers) and requires further attention in 1,2-D materials. These studies can include monomers whose lattices are nearly degenerate with their polymer lattices. Information regarding crystal structure of reactive monomers under conditions relevent to polymerization is insufficient to allow prediction of the direction of solid state polymerization.

(2) Initiation of chemical polymerization at well-defined, epitaxially oriented surfaces. Polymerization may be initiated thermally, photochemically or via chemical reactions with functional groups on the surface. Systematic investigation of the effect of well-defined surfaces on the morphological identity of chemically and electrochemically grown phases needs to be performed. Such surfaces include, but are not exclusive, surfaces modified by covalent attachment of appropriate reagents and Langmuir-Blodgett films.

(3) Spectroscopic investigation of monolayer and sub-monolayer films of dimensional materials on well-defined surfaces. Such techniques include infrared, Raman, SERS and EXAFS.

(4) Investigation of the growth of dimensional materials in anisotropic media. Examples include crystallization in liquid crystalline media, clathrates or in the presence of orienting electromagnetic fields.

(5) Investigation of directional control of crystal growth as a route to macroscopic organized structures.