CHEMISTRY & ELECTROCHEMISTRY OF LITHIUM INTERCALATED CARBON

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The intercalation compounds between lithium and carbon were studied extensively at the Laboratory for Research on Structure of Matter (LRSM) of University of Pennsylvania in the last thirty years; which included novel synthesis techniques, structural characterization, determination of physical, chemical and electrochemical properties. The theoretical physicists identified the stage I compound, LiC6, as a model material quite early, due to the simplicity of the molecule and crystal structure of the material. The synthesis of stage I and stage II compounds in Highly Oriented Pyrolytic Graphite (HOPG) through a liquid-phase intercalation technique developed at LRSM allowed the preparation of large samples of these novel materials in pure form. As a result, experimental verifications of theoretical predictions regarding crystal structure and physical properties of these materials were possible in LRSM and many institutions around the world.

The excitement created within the scientific community by the intercalation compounds of lithium and carbon was noticeable by the number of publications in the contemporary scientific literature in 1970s and 1980s. However, the application of these materials were in quite a different area of technology, unforeseen by the agencies of the US Government, which funded most of the R&D work at University of Pennsylvania.

The thermodynamic properties, especially the high chemical activity of the intercalated lithium in the stage I compound, LiC_6, and the rapid kinetics of formation of the compound during liquid phase synthesis, provided strong indications for the potential application of the material as an anode in rechargeable lithium batteries. It was not accidental that at the same time, Professor Wayne Worrell was leading an effort on rechargeable lithium batteries focusing on the lithium intercalated transition metal chalcogenides as cathode materials. The synergy between the two parallel R&D efforts in LRSM on two different types of lithium intercalation compounds worked remarkably well in establishing the anodic properties of LiC6 in rechargeable lithium batteries, both at high temperature as well as at room temperature.

The work on crystal structure, physical, chemical, and electrochemical properties of the lithium intercalated graphite at University of Pennsylvania and Bell Laboratories are reviewed in this paper. The important role played by these materials in solving a key problem in high energy density lithium based power storage devices, and the fundamental scientific basis for such applications are also reviewed.

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