

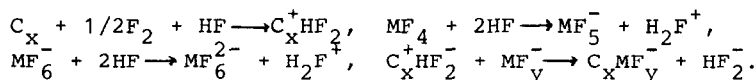
SOME NOVEL GRAPHITE INTERCALATION COMPOUNDS OF FLUORIDES, ELECTRICAL CONDUCTIVITY, AND ELECTROCHEMICAL CHARACTERISTICS AS A CATHODE MATERIAL FOR LITHIUM BATTERIES

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Intercalations of involatile fluorides such as SnF₄ and PbF₄ into graphite have been found in anhydrous liquid HF saturated by fluorine. Detailed X-ray analyses have revealed that the intercalation reaction proceeds through the substitution of bifluoride (HF₂⁻) by fluorometallate as follows;



Identity periods of C_xSnF_y and C_xPbF_y are, respectively, 11.53 and 11.48 Å. Average thickness of the intercalant are 4.9 Å for both compounds, which indicates the interlayer spacing between graphite layers including intercalants are governed by octahedral hexafluorometallate MF₆²⁻ or bipyramidal pentafluorometallate MF₅⁻. Detailed compositional, structural, and physical properties have been investigated on the basis of X-ray analyses, XPS, ¹⁹F-NMR, and Mössbauer spectroscopies.

The liquid HF-F₂ system will provide a novel synthetic pathway to graphite intercalation compounds with involatile fluorides. In fact, the GIC of borofluoride (C_xBF_y) has been successfully prepared in the LiBF₄-HF-F₂ solution.

In-plane electrical conductivity of higher stage compounds of C_xSnF_y is 5.4-7.4 times higher than that of pristine HOPG. An attractive feature of these GIC's is stability in moist air; only a slight change was observed in both X-ray diffraction pattern and conductivity after exposure to moist air over a period of one week.

Electrochemical characteristics of the GIC's as a cathode material for lithium batteries have been investigated by the cells; Li/1M-LiClO₄/C_xMF_y. These cells give very high open circuit voltage ranging from 3.9 to 4.2 V, however the overpotentials are considerably high, and the discharge potentials at 0.1 mA/cm² are 1.1-2.5 V with cathode utility more than 85%.