

Evolution of Optical Absorption and Superconductivity in Bi-2212 and 2223 Oxides Intercalated by Metal-phthalocyanines: A Systematical Study as a Function of Intercalation Level

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Abstract

Exposure to vapors of the metal-phthalocyanines MPc (M = Zn, Ni, Fe or Pb) brings about a systematical variation of optical and superconducting properties of Bi-2212 and 2223 high-T_c oxides. With increasing level of MPc uptake, the spectral weight is gradually transferred from the low to the high-frequency regions, accompanied by a decrease of T_c, diamagnetic response and magnetic hysteresis. Two different types of evolution patterns were observed: the first was characterized by a sharp change at the lowest level of MPc uptake (T_c, hysteresis), while the second featured a gradual evolution (intensities of the electronic absorption bands, diamagnetism). The heavily intercalated Bi-oxides are brightly colored non-conducting materials with well-resolved vibrational features due to both the intercalated MPc molecules and the host oxides.

The above evolution patterns are ascribed to a combination of two mechanisms: the decrease of the charge carrier concentration as a result of electron doping into the host oxide, and the increase of anisotropy of the system due to incorporation of insulating MPc molecular layer between the Bi-O bilayers, thereby reducing the coupling along the c-axis. Hence, the intercalation by MPc is shown to be an effective technique for the electron doping leading to a reduction of the charge carrier concentration in the host oxides, in contrast to the intercalation by iodine which leads to a hole doping and to an increase of the number of charge carriers.