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From high temperature superconductivity to Li-ion battery

High-temperature superconductivity observed in the cuprates and FeSe-based materials is strongly correlated with the novel Mott metal-insulator transition, which exists in many transition-metal chalcogenides. In this presentation, I shall review the discoveries, which I personally involved, of the high Tc cuprate and FeSe superconductors. I shall discuss more in-depth the current understanding regarding the origin of high Tc superconductivity based on our recent results on FeSe and related materials. The results suggest that the presence of ordered Fe-vacancy results in the metal-insulator transition. A proper treatment, either thermally or chemically, can disrupt the vacancy order to induce charge transfers between transition metal d-orbital and the chalcogen p-orbital, and subsequently lead to superconductivity. The concept of charge transfer from transition-metal oxides is the key to the development of high energy capacity cathode material for Li-ion batteries. Herein I'll present a designed Li-rich cathode material Li1.083Ni0.333Co0.083Mn0.5O2, which dominated by cationic redox reaction, exhibits high specific capacity and much less voltage fade. By reducing the excess lithium content to decrease the probability of Mn4+, Li+ and On- short-range ordering, the designed material significantly suppresses the voltage fade at around 3.0/3.3 V that provides a different prospect in the evolution of structural chemistry for Li-rich materials. A 60 mAh pouch cell displays 200 mAh/g initial capacity and 85% retention after 400 cycles in 0.2C charge/discharge rate. I'll present the details of the mechanism responsible for the long cycle-life test.

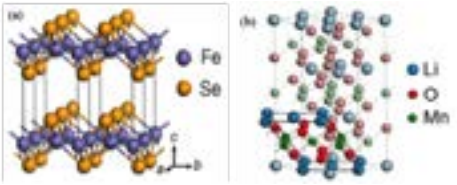

Figure: Schematic crystal structure of (a) FeSe superconductor, and (b) Li1.083Ni0.333Co0.083Mn0.5O2, (LNCM1416) cathode materials.

Biography

Maw-Kuen Wu is a distinguished research fellow at the Institute of Physics, Academia Sinica in Taiwan. He is a member of the Academia Sinica, Taiwan, a Foreign Associate of the US National Academy of Sciences as a Foreign Associate, and a member of the Academy of the developing countries. He has received awards including the Comstock prize, the Bernd T. Matthias Prize, the Humboldt Research Award, the Nikkei Asia Prize, the Ettore Majorana-Erice-Science Prize of Italy, and the Presidential Science Prize of Taiwan.

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