Novel Oxide Semiconductors for OLEDs and Catalysis

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We have studied transparent crystalline and amorphous oxide semiconductors toward oxide electronics in past 2 decades. Industrial application of TFTs using an oxide semiconductor In-Ga-Zn-O (IGZO) started to drive various types of flat panel displays such as LCDs and large-sized OLED-TVs. This is a visible fruit of this study.

Here I show new applications of novel type oxide semiconductor, electron-doped crystalline and amorphous $12CaO \cdot 7Al_2O_3$ (C12A7). Stoichiometric C12A7 is a major constituent of commercially available alumina cement, and is a typical insulator with a band gap of ~6.5eV. We succeeded in converting this to transparent conductor and metallic state by doping electrons via replacement of O^{2-} entrapped in the crystallographic cages with electron. The resulting C12A7:e may be regarded as *electride* in which electrons serve as anions. This material has unique physical properties arising from characteristic band structure, i.e., very low work function (2.4eV) but chemical inertness. We found Ru-loaded C12A7:e works as efficient catalyst for ammonia synthesis at ambient pressure and mild temperatures. Surprisingly, amorphous (a-) C12A7:e thin films prepared by conventional sputtering preserves almost the same electron concentration as crystalline C12A7:e. The resulting a-C12A7:e thin films are optically transparent and keep low work function of 3.0eV. Inverted device stacking structure is quite favorable with respect to stability and image clearness when oxide semiconductors such as IGZO are adopted as the driving TFTs for OLEDs. The large obstacle for inverted structure is the absence of appropriate electron injection layer for this purpose. We realized inverted type OLEDs with high performance comparable to conventional normal type employing a-C12A7:e.