Challenges on Environmental and Energy Issues Based on Functional Inorganic Materials

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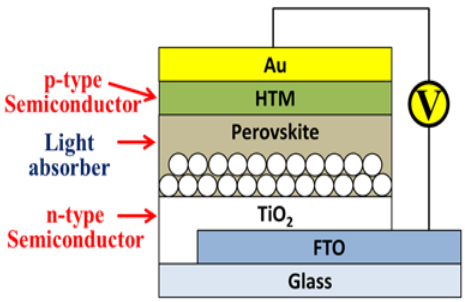
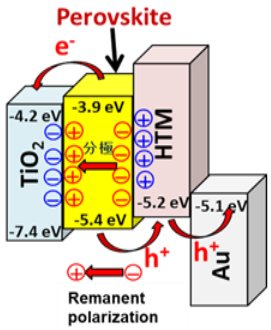
With the economic growth, energy and resources consumption has rapidly increased to create environmental and energy problems. We are facing the serious challenges to solve these environmental and energy problems. In our lab, we focus on the developments of inorganic functional materials to solve these problems, including new solar cells, high performance adsorbents for treatment of radiation-contaminated water, and eco-friendly materials.

1. Ferroelectric Semiconductor Perovskite Solar Cells

A new type of ferroelectric semiconductor solar cell is proposed. The synergistic effect of p-n junction and ferroelectric polarization charge separations enhanced the performance of perovskite solar cells which are different from normal semiconductor solar cells.



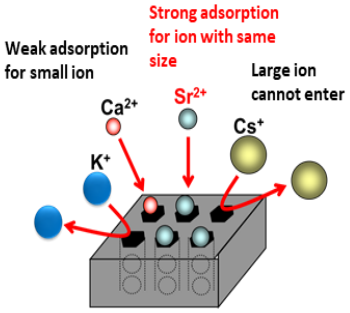
Structure of perovskite solar cell



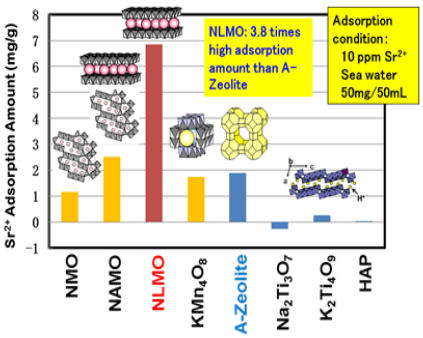
Charge separation in Ferroelectric Semiconductor Solar Cell

2. Sr^{2+} Adsorbent for Radiation-Contaminated Water Treatment

Ion-sieve effect is applied to development of high selective Sr^{2+} adsorbent for treatment of radiation-contaminated water of Fukushima No. 1 Nuclear Power Plant Accident. Porous manganese oxide with pore size same as Sr^{2+} ion size shows excellent ability for selective Sr^{2+} adsorption ever from sea water.



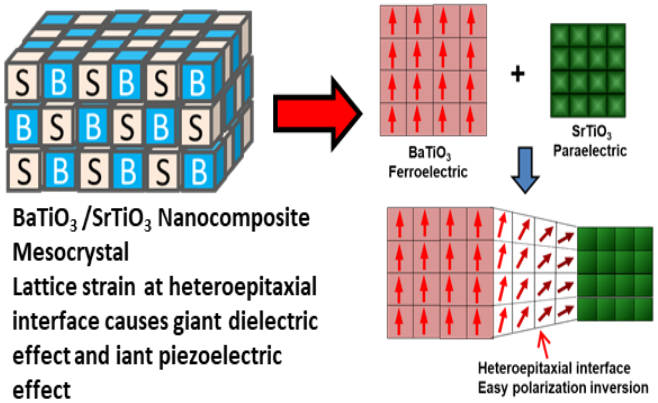
Ion-sieve effect for selective adsorption of Sr^{2+} with same size as pore size



Selective Sr^{2+} adsorption amount in sea water

3. Mesocrystals for Lead-Free Piezoelectric Materials

Mesocrystals constructed from oriented nanocrystals are employed to construct heteroepitaxial interface to introduce lattice strain. This lattice engineering provides giant piezoelectric and giant dielectric effects. Ferroelectric mesocrystalline nanocomposites show large piezoelectric response, which are promising materials for alternating lead-based piezoelectric materials widely used in piezoelectric devices.



$BaTiO_3$ /$SrTiO_3$ Nanocomposite Mesocrystal
Lattice strain at heteroepitaxial interface causes giant dielectric effect and iant piezoelectric effect