38-22 Synthesis and Photoluminescent Properties of Titanate/Rare Earth Complex Layered Oxide Films by Electrostatic Self-Assembly Methods

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We have demonstrated the intercalation and photoluminescent properties of various titanete/rare earth complex oxide thin films with layered structure composed of TiO_6 host layer between which rare-earth cations exist. The intercalation was carried out successfully with Electrostatic Self-assembly Deposition (ESD), and Layer-by-Layer Deposition (LBL) methods. Rare-earth cations in the interlayer exist in their 7-10 coordinated aqua ion forms according to XRD and thermal analysis data. The interlayer distance of 6-7 Å (angstrom) is large enough to accommodate a rare-earth aqua ion. Heat treatment by 300 ℃ (degrees centigrade) resulted in the shrinkage of the interlayer distance to lower values corresponding to the radius of bare rare-earth cations. Intercalation of rare-earth cations into the interlayer by LBL method was monitored by UV-vis spectrum and X-ray diffraction.

Eu^{3+} intercalated layered complex oxides showed strong red luminescence at room temperature. It was found that the luminescence is mainly contributed by the band gap excitation in the host nanosheet layer. Heat treatment and humidity controlled experiments revealed the importance of the surrounding water molecules for the high luminescence. The films treated with high humidity showed strong luminescence while heat-treated or dehumidified films showed relatively very weak luminescence. The mechanism was suggested that the ice-like behavior of the confined water molecules plays a supplementary role in the photoluminescence. Eletrons and holes migrating in the host layer move simultaneously through the surrounding water molecules to interlayer rare-earth cations to yield emission rather than giving radiationless quenching via energy transfer to OH vibrating molecules.

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