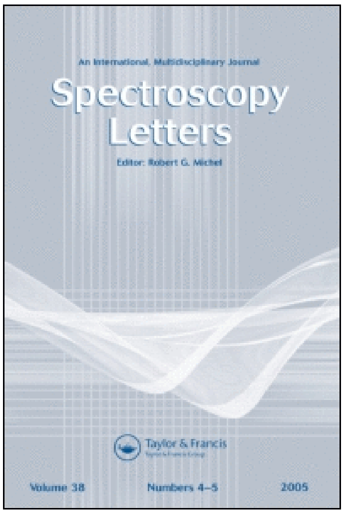

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Editorial

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Editorial

Spectroscopy of Lanthanide Materials

Despite the similar chemical properties of the lanthanide elements, the applications of lanthanide ions (Ln^{3+}) doped into materials span a wide range: from solid-state lasers, phosphors, scintillators, optical fibers, contrast agents, catalysts, high-temperature superconductors, biosensors, to areas such as chemical synthesis, tomography, magnetism, and biological assays. Some recent reviews focus upon their applications in medicine.[1,2] Although they are often called "rare earths," all of these elements are not particularly rare.[3] The current world reserve of these elements is estimated to be 150 million metric tons, with annual consumption at 120,000 tons.[4]

This special issue focuses on the spectroscopy of lanthanide ions in the solid state. It comprises a mix of theory and experiment that encompasses the physics, chemistry, and materials science of eight different lanthanide ions, with contributions from renowned authors from Sweden, Japan, China, New Zealand, Poland, France, Italy, and the United States. Most of the papers concern the most well-known aspect of the chemical physics of these materials: their luminescence. A brief overview is given here.

The energy transfer processes of various Ln^{3+} in YAG waveguides are investigated by Malinowski et al. Red and green upconverted luminescence of Er^{3+} in the efficient $NaYF_4$ phosphor is analyzed and interpreted by Wang et al. Zhou et al. find that the luminescence of Pr^{3+} in elpasolite lattices can be tuned by chemical variation of the (distant) fifth nearest neighbor and that the $4f^2$ energy levels of Pr^{3+} in these hosts are well-modeled by configuration interaction crystal field calculations. Trice and Tissue observe curious "dips" in the excitation spectra of Eu^{3+} emission and deduce that the origin of this phenomenon is upconversion. The search for phosphors that can be employed in mercury-free discharge lamps is well illustrated by Liang et al. who study the vacuum ultraviolet and visible spectra of Dy^{3+}-doped candidates. Fundamental basic conditions that determine gain flatness in an Er^{3+}-doped optical amplifier are investigated by Auzel. Charge transfer transitions form the focus of two papers. First, Brik and Ogasawara have performed first-principles fully relativistic calculations to explore the relationship between the 5d orbital splittings and charge transfer energies upon interionic distance. The application of this work to high-pressure studies is noted. Boutinaud et al. show that the visible emission of Pr^{3+} can be quenched by an intervalence charge transfer mechanism in oxide hosts containing closed-shell transition metal ions. In addition to some of the above studies, the final two papers comprise more theoretical viewpoints. The applicability and development of theoretical models that accurately describe the dependence of the spontaneous emission rate of Ln^{3+} in bulk or nanomaterials are presented by Duan and Reid. Finally, some new contributions to the transition amplitudes of Ln^{3+} are analyzed and a new parameterization scheme is introduced for $4f^N$ electronic spectra by Smentek and Kędziorski. The spectroscopy in the above papers mainly relates to the visible, ultraviolet, and vacuum ultraviolet regions. To add some balance to this issue, the application of electron paramagnetic resonance spectroscopy as a powerful analytical tool to probe the ground states of rare-earth ions is illustrated by Guillot-Noël et al.

Most students of chemistry and physics find that the luminescent colors of Ln^{3+} are both beautiful and fascinating. The names of lanthanides are very quaint, and students often amuse in giving pet names to them. A former Ph.D. colleague used to call terbium "tibbles," just like her cat. Actually, the word *lanthanide* comes from the Greek "to lie hidden," but the above selection of papers shows that lanthanides are shining very brightly throughout this volume. The reader is left to ponder the current truth of Sir William Crookes words[5]:

> 'lanthanons: these elements perplex us in our researches, baffle us in our speculations, and haunt us in our very dreams. They stretch like an unknown sea before us: mocking, mystifying and murmuring strange revelations and possibilities.'

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