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Funkcjonalne związki metali f-elektronowych: struktura, luminescencja, magnetyzm : od układów molekularnych po nanomateriały = Functional f-electron metal compounds: structure, luminescence, and magnetism : from molecular systems to nanomaterials

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Streszczenie

This article provides a concise review of research on functional f-electron metal compounds developed at the interface of coordination chemistry, spectroscopy, magnetochemistry and materials chemistry. It discusses molecular systems, nanomaterials, heterostructures and glassy matrices, with particular emphasis on lanthanide coordination compounds, nanofluorides, divalent lanthanide ions, hybrid materials, molecular magnets, and tellurite glasses and glass-ceramics. The central theme is the relationship between chemical structure, local symmetry of the metal centre, ligand-field interactions, coordination geometry, distribution of optically active ions, energy transfer and excited-state dynamics, and the resulting luminescent, magnetic and multifunctional properties. Special attention is given to the mechanisms of Ln^{3+} emission sensitization, the role of singlet, triplet and ligandto-metal charge-transfer states, upconversion and downconversion processes, thermometric behaviour, and magnetic relaxation in single-ion and single-molecule systems. The examples discussed demonstrate that even subtle changes in the first and second coordination spheres, crystal packing, matrix composition or nanoparticle surface chemistry may substantially modify emission quantum yields, lifetimes, magnetic anisotropy, optical sensitivity and the functional stability of the materials. Systems based on lanthanide ions and other f-electron elements show considerable potential as efficient radiation converters, luminescent labels and probes, temperature, pressure and chemical-environment sensors, materials for bioimaging, optoelectronic components, and molecular magnetic systems. The review emphasizes that rational design of f-electron materials requires the integration of synthesis, crystal and nanostructural engineering with quantitative analysis of photophysics and magnetic relaxation. This approach not only enables interpretation of structureproperty relationships, but also supports the deliberate development of a new generation of multifunctional materials for optics, sensing, bioanalysis and molecular magnetism.

Słowa kluczowe

lanthanides, coordination compounds, luminescence, nanomaterials, molecular magnetism

lantanowce, związki koordynacyjne, luminescencja, nanomateriały, magnetyzm molekularny

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