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Dopant-induced effects in zirconia-based materials: interrelation between structural transformation and luminescence variation

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Wide bandgap zirconia attracts considerable attention because of its mechanical, dielectric, thermal and corrosion properties as well as its broad luminescent spectrum. This latter can be tuned by doping with various elements. Doping with yttrium stabilises tetragonal and cubic zirconia structures at room temperature. Simultaneously, zirconia intrinsic luminescence changes because additional oxygen vacancies appear for Y charge compensation. Rare-earth elements introduced in Zr cites demonstrate specific luminescence which is very sensitive to host structure. This feature can be used to recognize the contribution of zirconia polymorphs. Thus, elucidating the interrelation between zirconia structure and intrinsic- and dopant-related luminescence is important. Such a study becomes more attractive when zirconia is codoped with several impurities.
In the present work, the structural and light-emitting properties of undoped, Y-doped and (Y, Eu)-co-doped zirconia ceramics sintered at 1100–1600 ℃ were analyzed using Raman scattering, IR reflection spectroscopy, UV-vis diffuse reflection and XRD methods. Luminescence and luminescence excitation spectra were studied using the DESY synchrotron facilities (PETRA III beamline P66) in the 200-900 nm and 120-330 nm spectral ranges, respectively, at helium and room temperatures. The analysis of exciton-emission maps allowed us to separate the contribution of host-related and dopant-related luminescence, and to get insight on the luminescence excitation mechanism. Based on the complex characterization, the approach for monitoring zirconia lattice transformation using optical methods was proposed.
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