Charge traps in Zn- and Mo-based oxide microstructures. The role of Mo

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ZnO-based nanostructures are highly promising materials for application in photo-catalysis, supercapacitors, light emitting diodes, energy harvesting and storage systems. Doping the ZnO with different ions may improve fast exciton emission and suppress the defect-related emission bands, which further opens applications in ultrafast scintillation detectors. Here, we specifically focus on the role of Mo doping. We combine X-ray powder diffraction (XRPD), X-ray photoelectron spectroscopy (XPS), scanning electron microscopy (SEM) and electron paramagnetic resonance (EPR) to study the ZnO:Mo(10, 30%) and MoO_3 microstructures synthesized in the powder by the hydrothermal growth method. The ZnO:Mo(10%) has been shown to contain complex molybdenum-based oxides existing in the form of platelet flakes beside the Wurtzite ZnO. The ZnO:Mo(30%) consists mostly of complex zinc molybdates and of only a negligible amount of ZnO phase, which is beyond the detection limits of XRD. According to XPS measurements molybdenum exists as Mo^{6+} on the surface of ZnO:Mo samples. The MoO_3 sample is composed of two phases in the form of microneedles: hydrated and anhydrous MoO_3 phases. We further address an important topic of ZnO:Mo aging under X-ray irradiation, which cannot be avoided during scintillator operation. We observe X-ray induced formation of point defects, which we assign to the oxygen-based electron and hole trapping centers (O^- or O_2^-) and Mo^{5+}-based electron trapping centers. Part of them is expected to exist in the pure ZnO and MoO_3 phases whereas the rest must appear in the complex zinc molybdates.

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