ZnO nanorods heavily doped with Mo/Er. The effect of post-deposition treatment on defect states and luminescence

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Among the most attractive classes of materials one may point out scintillators which transforms high energy ionizing radiation into optical photons. This allows detection tools to operate basing on conventional photomultipliers or semiconductor-based devices. Diseases diagnostics is one of the most demanding fields of the scintillators application. It is supplied by the data provided by e.g., computer tomography (CT) and positron emission tomography (PET). The latter is exceedingly sensitive in the time-of-flight (TOF) PET extension. This requires the improved timing coincidence resolution (TCR) of the scintillating system. The TCR reaching 500 ps is now realized in commercial devices, however, the expected limit of the TCR for a scintillating material is 10 ps.

Presently, excellent timing properties have been observed in zinc oxide (ZnO) nanostructures like, e.g., nanopowders, free-standing (hedgehog) or deposited nanorods. Photoluminescence (PL) spectrum measured in these ZnO-based nanomaterials is complex. In most cases (as grown material) it is composed of a very broad defect-related band covering almost the whole visible range. It exhibits slow decay. Post-deposition treatment, conditions of growth, additional doping or all this altogether can result in a narrow UV exciton band appearance whereas the defect-related band can be suppressed [1, 2]. This paves the way for the material properties tuning to make use of each of these bands separately. This in turn requires deep understanding of the energy and charge transfer processes including trapping of charge and defects creation. Therefore, this work is aiming at comparison of undoped and the heavily Er, Mo-doped zinc oxide nanorods to find out the peculiarities of the energy and charge transfer and the possibilities of the nanorods improvement. Paramagnetic Er^{3+}, Mo^{3+} and Mo^{5+} ions can be detected by means of electron paramagnetic resonance (EPR). Therefore, they can serve as local point probes in the material. Post-growth treatment of the ZnO:Er/Mo by air annealing results in reduction of F^{+} centers. Red emission appears. EPR results were correlated to the RL, PL and thermally stimulated luminescence (TSL) data as well.

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