Tunable visible emission in nanostructured ZnO thin films.

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ZnO is a promising wide bandgap semiconductor with a wide range of potential applications in different areas[1-4]. It is well known, that the PL spectrum of ZnO is characterized by two features, the near band-edge excitonic emission (NBE) in the UV region and the defect-related emission (DLE) in the visible region [5]. For the majority of optoelectronic applications, the presence of DLE emission is undesirable and a variety of approaches have been developed to suppress the DLE emission by different methods such as hydrogen plasma treatment, thermal treatment, or other surface passivation methods including the deposition of Al_2O_3 or polymer layers. Nevertheless, the broad DLE emission band in ZnO, which covers almost the whole VIS region, can be exploited in the fabrication of white light-emitting diodes, display devices, or biological labeling. Of particular importance is the need to develop new highly efficient materials for white light-emitting diodes (LEDs) and replace conventional lighting sources, which combine a white-light-emitting phosphor with a UV LED chip. While commercial rare-earth phosphors and traditional semiconductor QDs show a narrow bandwidth emission, the characteristic broad emission band makes ZnO an ideal candidate for white LEDs.

In this work, we show that the visible emission from a thin ZnO film can be manipulated by simply varying the annealing atmosphere and temperature, and consequently, the DLE emission can be tailored towards a particular application [6]. We demonstrated a strong correlation of the blue luminescence band with surface-related defects. This band has been rarely observed in ZnO thin films and was mostly associated with zinc-related intrinsic defects. We also confirmed the formation of willemite after annealing at temperatures above 700°C, which can affect the optical properties; however, in previous reports, its presence was not considered.

This work was supported by the Czech Science Foundation, Project No. 20-24366S.

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