Visible photoluminescence of aged $Zn(acac)_2/C_2H_5OH$ solution: emission/excitation/kinetics study

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Liquid solutions of Zinc acetylacetonate $Zn(acac)_2$ are known to be used for synthesis of ZnO nanoparticles under elevated temperature. It was demonstrated that such processes are effective for the synthesis of ZnO nanoparticles but the reproducibility of nanoparticles morphology (size, shape etc.) is poor due to fast agglomeration/nucleation/growth under heating. In the present work we studied the processes of ZnO clustering and formation of nanoparticles in $Zn(acac)_2$/ethanol solution without intentional heating but by "natural aging" at room temperature conditions. Ethanol solutions of $Zn(acac)_2$ with different concentrations (0.4-10%) were prepared and their photoluminescence was monitored for time period of several months. During the aging, the initial colorless solution gradually changed from colorless to yellowish. These changes were accompanied by the emergence of strong visible broad band photoluminescence that spans the spectral range of 375-600 nm. Detailed emission/excitation study revealed that the emission band is composed of at list two bands centered at about 420-450 nm and 500 nm, with the corresponding excitation bands at 365 nm and 420 nm. Time-resolved measurements showed that the decay of low energy emission band follows the classical mono-exponential low with the characteristic time of several nanoseconds, while the behavior of high energy band can be described by the stretched exponential low with the average decay time of several nanoseconds. Photoluminescence of the aged solutions is compared with the characteristics of crystalline ZnO photoluminescence and discussed in terms of the formation of amorphous ZnO nanoparticles and aggregation-induced photoluminescence.