Nanosecond photoluminescence decay in Mo-doped ZnO nanorods observed by TCSPC and phase shift methods

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Hydrothermally grown, pellet-pressed Mo-doped zinc oxide (ZnO) nanocrystals were investigated for time-resolved photoluminescence at room temperature under UV excitation. Two optical setups were compared. The TCSPC setup was based on ns-short-pulse excitation followed by time resolved histogram-like counting of emitted photons. The phase-shift method was based on the frequency-resolved phase delay between sinusoidal excitation and emission [1]. Whereas the TCSPC method is nowadays a commercially available and widely used, the second method was built as a low-cost student's setup with a conventional UV LED as the excitation source, sine-wave voltage generator, an old dispersive monochromator, optical band-pass and long-pass filters, a red-enhanced photomultiplier and a lock-in amplifier [2]. Recently, the setup was upgraded by a new HF2LI Zurich Instruments 50 MHz lock-in amplifier, which also includes pulse generator and a current amplifier to measure the PMT photocurrent. Both methods gave a similar time resolution slightly below 1 ns. While the time resolution of the TCSPC was limited by the excitation pulse width, the time resolution of the phase shift method was limited by the maximum operating frequency of the UV LED (several MHz). To be able to measure the PL decay in ps range, we need to replace UV LED by a new, faster UV excitation source to increase the excitation frequency up to the 50 MHz limit of our lock-in amplifier.

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