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SYNTHESIS OF ZnO NANOCCLUSERS AND PULSED LASER DEPOSITION OF NANOCRYSTALLINE FILMS FOR OPTOELECTRONIC APPLICATIONS

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Controlled synthesis of nanostructured materials is an important challenge for numerous applications in different areas of nanoelectronics and photonics. Among the other semiconductors, zinc oxide is considered as one of the most promising materials for the realisation of light emitting diodes and non-linear optoelectronic devices.

We present a method to synthesize ZnO nanoclusters and to deposit nanostructured films by pulsed laser ablation. The nanoclusters are condensed in the laser-induced plume, which is confined by an ambient gas. Even in vacuum, the small clusters have been detected by time-of-flight mass-spectrometry. The presence of the surrounding gas favors the synthesis and growth of the clusters. We observed very rich cluster populations and we demonstrated chemical reactions between the ablated particles and the ambient gas. The initial cluster ions play a role of condensation centers for the further cluster growth up to sizes of several nanometers. Under laser excitation, we have observed the photoluminescence (PL) of the gas-suspended clusters. The PL spectra of the gas-suspended clusters showed a narrow band corresponding to the exciton recombination in the nanoclusters, which are already cooled down and crystallized.

The PL spectra of the nanocrystalline films showed a strong exciton band and a weak defect-related band. These defects are due to local oxygen amount in the films and can be controlled by optimizing the deposition conditions and by post-growth laser annealing. The films have been annealed with laser fluences both, below and above the melting threshold in air and in hydrogen ambient. We show that annealing in air modifies the intensity and spectral position of defect emission band, and annealing in hydrogen ambient suppresses this emission. However, in both cases the intensity of UV light emission increases drastically. The effects of laser fluence and annealing ambient on the optical properties of the films will be discussed.

We have shown a very high efficiency of the conversion of the femtosecond laser radiation to the third-harmonic in submicron-thick ZnO films. Finally, we report a very strong optical amplification and a laser effect due to the optical cavities formed by light scattering in the nanostructured films.