Lasing from a Se-based microcavity embedding a CdSe/(Cd, Mg)Se superlattice

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A large exciton oscillator strength proper for II-VI semiconductors makes them an excellent material for implementation in optoelectronic devices exploiting light-matter coupling phenomena.

Our previous studies have shown that CdSe/(Cd,Mg)Se superlattices exhibit an order of magnitude enhanced emission with respect to a single CdSe/(Cd,Mg)Se quantum well containing the same total thickness of CdSe.[1] This indicates superlattices as a promising material for implementation in semiconductor lasing devices involving CdSe.

In this work, we report on a low threshold lasing achieved under optical pumping in a new structure that contains a wedge-type $\lambda/2$-microcavity embedding ten period stack of 1 nm thick CdSe and 2 nm thick $Cd_{0.75}Mg_{0.25}Se$ layers. The microcavity of quality factor attaining 3000 is made of $Cd_{0.75}Mg_{0.25}Se$, while the Distributed Bragg Reflectors surrounding the microcavity are constituted by ZnTe layers and short period superlattices MgSe|ZnTe|MgTe|ZnTe.

The emission is excited at temperatures between 2 and 300 K using a Ti:sapphire laser operating in a picosecond mode combined with the OPO (λ_{exc} = 600 nm). A microscope objective ensures 1 μm diameter of the excitation spot. The emission dynamics is measured using a streak camera.

Reflectivity spatial mapping measurements reveal a characteristic anticrossing between the cavity mode and the exciton confined in the superlattice, which confirms that the studied system operates in the strong coupling regime. The Rabi splitting is determined to 19 meV.

The measurements of the emission intensity *vs* the excitation power reveal a strong non-linear dependence disclosing a lasing threshold at around 36 kW/cm^2. The onset of the lasing is accompanied by a blueshift and a narrowing of the emission. The photoluminescence emission exhibits a strong linear polarization above the threshold. Time resolved measurements show that below the threshold the rise and decay of the emission is relatively slow (in several ns range), while above threshold both, the build-up of the emission and the decay, are significantly accelerated (to tens of ps range) and accompanied by a strong blueshift of the emission line.

The above features suggest that the observed lasing can be attributed to a massive occupation of the lowest energy state and a radiative decay of the polaritons, which, however, cannot be clearly confirmed in angle-resolved measurements carried out in photon momentum space. The lasing is preserved up to room temperature, with the threshold increased for two orders of magnitude.

[1] Rudniewski *et al.*, APPA 126, 1167 (2014).