FNM 2016 Program Committee cordially invites people to submit abstracts for The International Workshop on Functional and Nanostructured Materials to be held in Tbilisi, Georgia 6th -10th September 2016.

Photonics and polaritonics with van der Waals heterostructures

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Monolayer films of van der Waals crystals of transition metal dichalcogenides (TMDCs) are direct band gap semiconductors exhibiting excitons with very large binding energies and small Bohr radii, leading to a high oscillator strength of the exciton optical transition. Together with graphene as transparent electrode and hexagonal boron nitride (hBN) as an insulator, TMDC monolayers can be used to produce so-called van der Waals heterostructures. Here we use this approach to make electrically pumped light-emitting quantum wells (LEQWs) [1,2] and single-photon emitters [3]. We combine this new technology with optical microcavities to demonstrate control of the emitter spectral properties and directionality, making first steps towards electrically injected TMDC lasers. Furthermore, by embedding $MoSe_2$/hBN structures in tuneable microcavities, we enter the regime of the strong light-matter interaction and observe formation of exciton-polaritons. We demonstrate that the magnitude of the characteristic anti-crossing between the cavity modes and the $MoSe_2$ excitons (a Rabi splitting) can be enhanced by embedding a multiple-QW structure, containing two $MoSe_2$ monolayers separated by an hBN barrier. At a temperature of 4K, for a single QW sample the vacuum Rabi splitting of 20 meV is observed for the neutral exciton state, which is increased to 29 meV for the double QW [4]. We extend this work to demonstrate valley addressable polaritons in both $MoSe_2$ and WSe_2, the property inherited from valley excitons, but strongly modified through changes in exciton relaxation in the strong-coupling regime. This work opens a new avenue in the field of polaritonics in a new material system of van der Waals crystals and heterostructures with a potential for polariton devices operating at room temperature.

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