ULTRA HIGH QUALITY FACTOR ON PHOTONIC CRYSTAL MICROCAVITIES AND LATTICES: A PATH FOR ULTRA LOW THRESHOLD LASING AND OBSERVATION OF CAVITY-MEDIATED STRONG COUPLING

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Laser emission of a compact surface-emitting microlaser, optically pumped and operating around 1.55 μm at room temperature is presented. The two-dimensional photonic crystal is conformed in a hybrid triangular-graphite lattice designed for vertical emission. The structures have been fabricated on InP slabs. The heterostructure consists of four $In_{0.65}As_{0.35}P/InP$ quantum wells grown on an InP substrate by molecular beam epitaxy and it is transferred onto a silicon-on-silica substrate by wafer bonding (SiO_2 thickness = 0.9±0.1mm). Standard techniques of electron-beam lithography, reactive ion beam etching and reactive ion-etching have been used for the patterning. The optical characterization was performed by micro-photoluminescence spectroscopy. Single-mode, strongly polarized laser emission has been achieved with quality factors Q exceeding 15000.

We show laser emission from the hybrid triangular-graphite lattice at the Γ point. This lattice was introduced with the aim of combined the good properties of the triangular and graphite lattice [1]. The structure has several bands with slow curvature close to the high symmetry points. The lattice was fabricated in III-V semiconductor slab [2]. The structure presents a strong photoluminescence around 1500 nm. The hybrid triangular-graphite lattice was fabricated with lattice parameters R/a=0.12, Rg/a=0.17, and several values of a=840-1050nm at steps of 20nm. Guide-mode expansion method for band calculation [3] has been used. The structures are fabricated on squares with sides around 30 μm. Polarization resolved micro-photoluminescence spectroscopy was used for optical characterization. The samples were optically pumped with a 780nm laser diode through a NA=0.14 (5x) objective placed at normal incidence. The PL emission was collected by a fiber coupled to a optical spectrum analyzer. Several lasing devices operating around 1.55μm with thresholds of a few of hundreds of microwatts showing polarized emission have been measured.

Moreover, room temperature lasing at 1.5 μm has been obtained in photonic crystal microcavities with self-assembled quantum wire nanostructures. Ultra low threshold values of 10μW along world-record quality factors exceeding Q=32000 have been measured using L7-type photonic crystal microcavities. The results open the way to the observation ot strong coupling at room temperature and ultra low threshold laser emission.

References

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Figures:

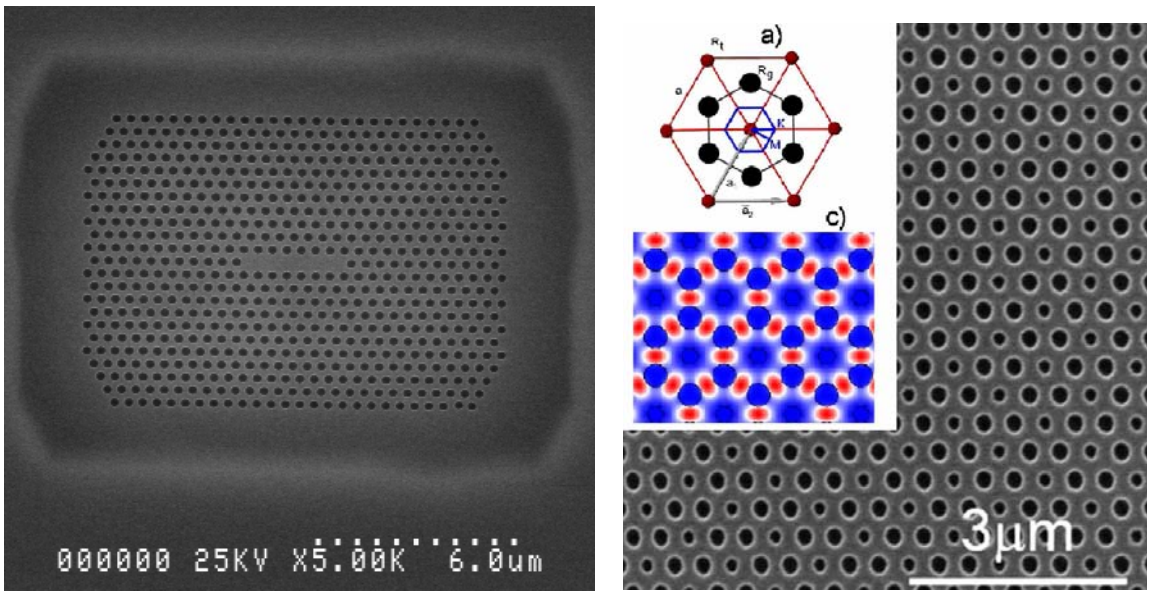
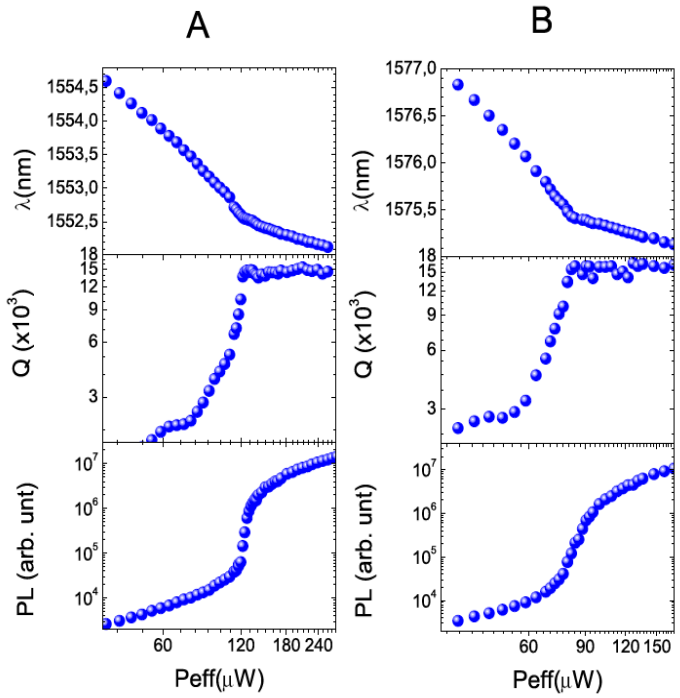


Fig.1. Left: SEM picture of a L7 cavity made on InP-based material with Q-factor exceeding 32000. Right: SEm picture of the hybrid triangular-graphite photonic crystal lattice. Inset: a) layout of the lattice. C) normalized E-field intensity profile at the G3 point.



Evolution with the excitation effective power for two (A and B) hybrid triangular-graphite photonic crystal lattices like the shown in Fig.1. Qs up to 15000 have been observed.