Centre de Nanosciences et de Nanotechnologies

Soutenance de thèse

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Auditorium de Institut d'optique Graduate School
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"Mid-Infrared Detectors and THz Devices in the Strong Light-Matter Coupling Regime"

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Résumé :

After fifteen years of intersubband polaritons development some of the peculiar properties of these quasi-particles are still cryptic. A deeper comprehension of the polariton's is needed to access their fundamental properties and reassess their applicative potential as efficient emitters or detectors in the mid-infrared and THz.
In this manuscript we used Metal-Insulator-Metal (M-I-M) cavities with a top metal periodic grating as a platform to deepen the understanding of ISB polaritons. The advantages of M-I-M are twofolded: first they confine the TM_{00} mode, second the dispersion of the cavity -over a large set of in-plane wave-vectors- offers various experimental configurations to observe the polaritons in both reflection and photo-current. Under this scope we reexamined the properties of ISB polaritons in the mid-infrared and in the THz.
In the first part we explore the implementation of dispersive M-I-M cavity onto THz intersubband transition. In the THz domain the scattering mechanisms of the THz ISB polaritons need to be qualified. The dispersive cavity is a major asset to study these mechanisms because it provides more degrees of freedom to the system. For this purpose, we fabricated a new experimental set-up to measure the polariton dispersion at liquid Helium temperature. After the characterization of the polaritons in reflectivity, a pump-probe experiment was performed on the polariton devices.
The second part of this manuscript presents the implementation of M-I-M dispersive cavities onto a bound-to-quasi-bound quantum well infrared photo-detector designed to detect in strong coupling. Beyond electrical probing of the polaritons, the strong coupling can disentangle the frequency of detection (Edetection= hfdetection) from the thermal energy activation (Eactivation) and reduce the dark current at a given frequency.
In parallel to the exploration of THz polaritons we developed two techniques in order to shorten the pulses of THz quantum cascade lasers in a double metal waveguide: first by increasing the spectral gain of the active region (broad band), second by reducing the free spectral range (anti-reflection coating).

Mots clés en français : Hétérostructure photonique,Polariton,Inter-sous bande,Laser,Couplages Faible/Fort,Fréquence de Rabi

Mots clés en anglais : Graded photonic heterostrucutre,Polariton,Inter-sub band,Laser,Weak/Strong coupling,Rabi frequency

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