Group velocity dispersion and identification of resonant modes in GaAs optical microcavities.

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Abstract

In this work we present an optical characterization realized in gallium arsenide (GaAs) microcavities in order to study resonant radial modes and the dispersion of the modes. These cavities are small disks with 5um up to 40um radius, fabricated with eletronic lithograph in a GaAs-AlGaAs layer and wet corrosion with HF.

Key words:

Dispersion, modes, microcavities.

Introduction

To understand the electromagnetic field behavior inside the cavity we can use modal expansion of both electric and magnetic fields[1]. Using Maxwell's equations and orthogonality relations among the modes we obtain as result the temporal evolution of the optical field in the cavity, a(t). In special, when the field is steady, that is, the derivative of a(t) is equal zero, we can find the expression for the transmittance and reflectance towards the identification of the resonant modes. The quality factor measured from the resonance indicates the lifetime of the photons inside the cavity.

Another approach is related to group velocity dispersion (GVD), or more precisely, the velocity of the envelope of the signal, in this case, the electric field transmitted to the cavity by the evanescent field of the *taper*[2]. After all, we seek to comprehend several optical phenomena due to the interaction of light and matter.

Results and Discussion

To acquire all the data needed to the analysis we used an experimental setup equipped with a tunable laser in the infrared spectra, a Mach-Zehnder Interferometer (MZI) and an acetylene cell.

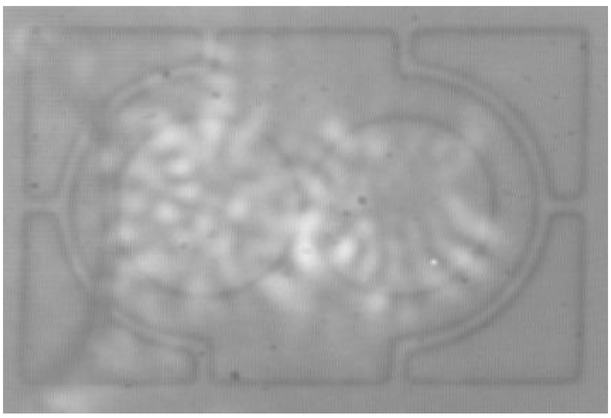

Image 1. Infrared image of the light emission of a resonant mode in coupled disks.

Thenceforward, we are able to identificate de resonant modes, as seen in image 1, of the cavity with the transmission data, calculated from the transmittance. Each result is different from cavity to cavity due to structural differences as roughness and because certain debris are deposited in the sample during the fabrication process in the corrosion with hydrofluoric acid (HF).

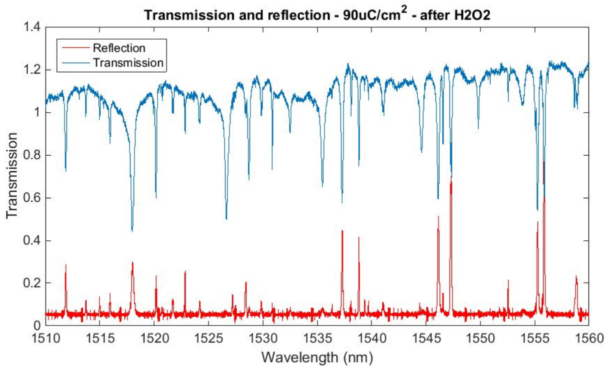

Image 2. Transmission and reflection for a cavity fabricate with dose of 90uC/m² and after the cleaning with H_2O_2.

The quality factor is highly affected by the fabrication process. The roughness, as an example, create back scattering points to the light to return. In image 2 we can see the reflection and transmission of the cavity. The resonant modes, one of the aims of this project, are also seen in the image 2 where the transmission have a quick fall.

Conclusions

The experimental investigation allowed us to perceive how much the quality factor is related to the aspects of fabrication. The theory behind the experiment takes over wave phenomena such as scattering, dispersion due to wavelength change and others nonlinear effects.

Acknowledgement

Special thanks for LPD at IFGW/UNICAMP and to CNPq who supported this work financially.

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