



**HAL**  
open science

## High-quality-factor double Fabry–Perot plasmonic nanoresonator

Baptiste Fix, Julien Jaeck, Patrick Bouchon, Sébastien Héron, Benjamin Vest,  
Riad Haïdar

► **To cite this version:**

Baptiste Fix, Julien Jaeck, Patrick Bouchon, Sébastien Héron, Benjamin Vest, et al.. High-quality-factor double Fabry–Perot plasmonic nanoresonator. *Optics Letters*, 2017, 42 (24), page 5062 - 5065. 10.1364/OL.42.005062 . hal-01708885v2

**HAL Id: hal-01708885**

**<https://hal.science/hal-01708885v2>**

Submitted on 19 Dec 2018

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# High quality factor double Fabry-Perot plasmonic nanoresonator

*Baptiste Fix*<sup>1</sup>, *Julien Jaeck*<sup>\*1</sup>, *Patrick Bouchon*<sup>1</sup>, *Sébastien Héron*<sup>1</sup>, *Benjamin Vest*<sup>1</sup> and *Riad Haïdar*<sup>1,2</sup>

<sup>1</sup> DOTA, ONERA, Université Paris Saclay F-91123 Palaiseau - France

<sup>2</sup> Ecole Polytechnique, Département de Physique, 91128 Palaiseau, France,

\**baptiste.fix@onera.fr*

Fabry-Perot (FP) like resonances have been widely described in nanoantennas. In the original FP resonator, a third mirror can be added, resulting in a multimirror interferometer. However, in the case of a combination of nanoantennas, it has been reported that each antenna behaves independently [1]. Here, we evidence the interferences between two detuned reflective FP nanoantennas through a common mirror, which has a strong impact on the optical behavior. While the resonance wavelength is only slightly shifted, the level of reflectivity decreases to nearly 0%. [2]

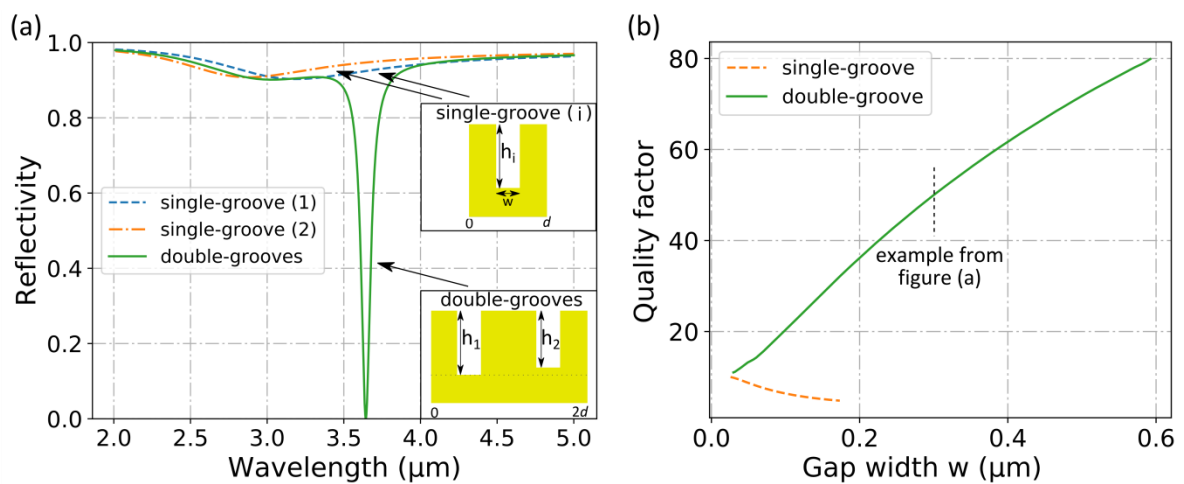


Figure (a). Comparison between the reflectivity of two loosely-coupled single-nanogroove resonators and the reflectivity of a critically coupled resonator composed of the two aforementioned cavities. The geometrical parameters of the cavities, described in the insets, are  $d=1 \mu\text{m}$ ,  $w=0.3 \mu\text{m}$ ,  $h_1=0.62 \mu\text{m}$ ,  $h_2=0.55 \mu\text{m}$ . Figure (b). Evolution of the quality factors of a single-groove resonator and of double-groove resonator with regard to the grooves width.

We study a periodic double-groove resonator whose period contains two grooves of different heights. While the reflectivity of the periodic single-groove resonators does not go below 85%, the resonance of the double-groove presents a zero of reflectivity and a quality factor of 50 (See Figure (a)). Moreover, the quality can be chosen by geometric design over a range from 11 to 80 (See Figure (b)).

We demonstrate thanks to a simple analytical model that this coupling can be ascribed to a double FP cavity resonance, with the unique feature that the cavities are coupled to one another through a common mirror.

The description of the double-groove resonator paves the way to the manipulation and the engineering of the equivalent mirror coupling the two nanocavities, in order to reach multimirror interferences predictions. This structure is also very promising for practical applications of the nanogroove system, as it relaxes the technological constraints on the groove (wider aperture, lower aspect ratio).

The authors acknowledge the financial support from a DGA-MRIS scholarship.

[1] C. Koechlin, P. Bouchon, F. Pardo, J.-L. Pelouard, and R. Hadar, *Opt. Express* 21, 7025 (2013).

[2] B. Fix, J. Jaeck, P. Bouchon, S. Héron, B. Vest, and R. Haïdar, *Opt. Lett.* 42, 5062-5065 (2017)