Quantum plasmonics

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In this talk, we report experiments aiming at exploring the physics of surface plasmons in the single plasmon regime. In other words, we revisit quantum optics using surface plasmons: tests of the wave-particle duality of surface plasmons [1], two photon interference on a lossy beam splitter[2], and the observation of entanglement between a photon and a plasmon[3]. In order to perform these experiments we have designed and built a plasmonic chip shown in Figure 1. The experiments confirm the wave-particle duality of the surface plasmons and the possibility to entangle a photon and a plasmon. New effects were discovered when illuminating the beam splitter with two plasmons, one on each channel, in the so-called Hong-Ou-Mandel configuration.

References

[1] MC Dheur, E. Devaux, T.W. Ebbesen, A. Baron, JC Rodier, JP Hugonin, P. Lalanne, JJ Greffet, G. Messin, F. Marquier, Science Advances **2**, (2016), e1501574.

[2] B. Vest, M.C Dheur, E. Devaux, A. Baron, E. Rousseau, J.P. Hugonin, J.J. Greffet, G. Messin, F. Marquier, Science **356**, 1373 (2017)

[3] M.C. Dheur, B. Vest, E. Devaux, A. Baron, J.-P. Hugonin, J.J. Greffet, G. Messin, F. Marquier, Phys.Rev.B **96**, 045432 (2017).

Figures

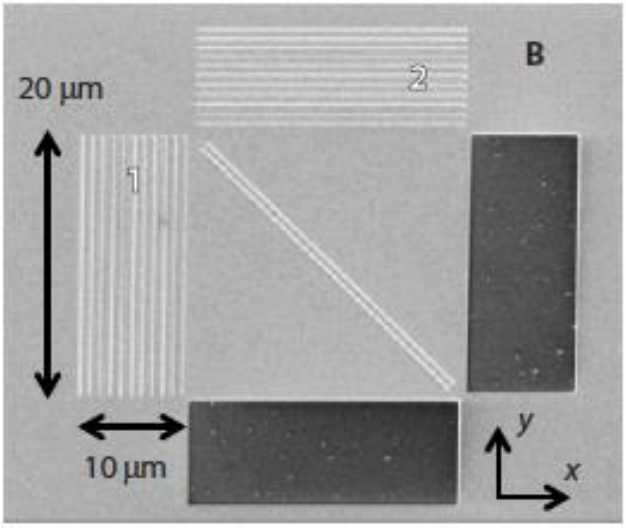

Figure 1: Photograph of the plasmonic chip. Two gratings (1 and 2) are used to couple noramlly incident photons into surface plasmons polaritons. The grooves along the diagonal serve as a beam splitter for surface plasmons. After transmission or reflection by the beam splitter, the surface plasmons propagate towards the slits where they are coupled iinto photons.