



From Sum Frequency Generation to Spontaneous Parametric Down Conversion in hybrid nonlinear plasmonic structures

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Nonlinear optical processes are the core of many technologies such as quantum cryptography or non-invasive multiphoton microscopy. However, the intrinsically weak response of bulk nonlinear materials prevents one from directly downsizing components to the nanoscale, making on-chip applications out-of-reach.

To overcome this issue, a possible path is to combine two complementary nanosized elements with specific properties into a single hybrid structure. In my thesis project, I have developed and used a versatile, computer-controlled setup (Fig.1a) to study homemade optimized hybrid nanostructures composed of plasmonic antennas for near-field enhancement, and a nonlinear

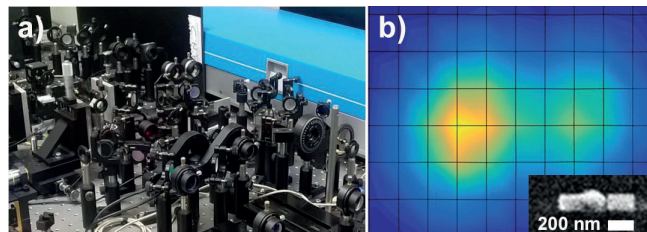
KTP nanocrystal for nonlinear conversion efficiency (Fig.1a). We want to optimize two kinds of coherent processes: Sum Frequency Generation (2 photons merging into 1) and Spontaneous Parametric Down Conversion (1 photon splitting into 2). One possible objective is the entangled photon pair production with an individual nanostructure compatible with on-chip integration. Such a device based on entangled photon pairs is contemplated for the development of decision-making strategies algorithm with applications for resource allocating or deep learning algorithms.

OUTCOMES

- [1] Wave-mixing origin and optimization in single and compact aluminum nanoantennas, ACS Photonics 3, 1840 (2016)
- [2] Collective decision making based on entangled photons (submitted);
- [3] Photon-pair production at the nanoscale with hybrid nonlinear/plasmonic antennas (submitted).

Invited oral presentations: COST NQO – GDR Ondes, Marseille, 2016; C2C symposium, Tokyo, 2018.

Collaboration: M. Naruse, NICT, Tokyo, Japan.



a) Experimental setup developed. b) 2D Second Harmonic Generation cartography of a hybrid nanostructure (inset: corresponding SEM image).