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Dual focused ion beam nanofabrication of V-grooves in monocrystalline gold for efficient excitation of organic single photon emitters

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Single dibenzoterrylene (DBT) molecules in anthracene nanocrystals have been shown to emit single photons without blinking, bleaching or spectral diffusion. Efficient integration of these molecules into photonic circuits will pave the way toward the realization of quantum optical networks. We incorporated anthracene nanocrystals containing single DBT molecules into plasmonic V-grooves milled with a focused ion beam in monocrystalline gold flakes. The fabricated V-grooves exhibit high-quality low-loss guiding of channel plasmon polaritons with the propagation length reaching $\sim 14 \mu\text{m}$ at a wavelength of 800 nm. For DBT molecules coupled to the V-grooves, we observe enhanced emission decay rates with up to 50% of the emission being funneled into channel plasmon polaritons [1].

In particular we utilized a two-step focused ion beam lithography process to fabricate V-grooves with defined dimensions, smooth sidewalls and inclined end-faces on monocrystalline gold flakes. The subsequent application of gallium and helium focused ion beams (GaFIB/HeFIB) provided by a commercial instrument (Zeiss Orion Nanofab) allowed us to fabricate waveguides of the required size and shape at reasonable fabrication speed.

[1] Kumar, S.; Leissner, T.; Boroviks, S.; Andersen, S. K. H.; Fiutowski, J.; Rubahn, H. G.; Mortensen, N. A.; Bozhevolnyi, S. I. Efficient Coupling of Single Organic Molecules to Channel Plasmon Polaritons Supported by V-Grooves in Monocrystalline Gold. *ACS Photonics* 2020, 7 (8), 2211-2218.

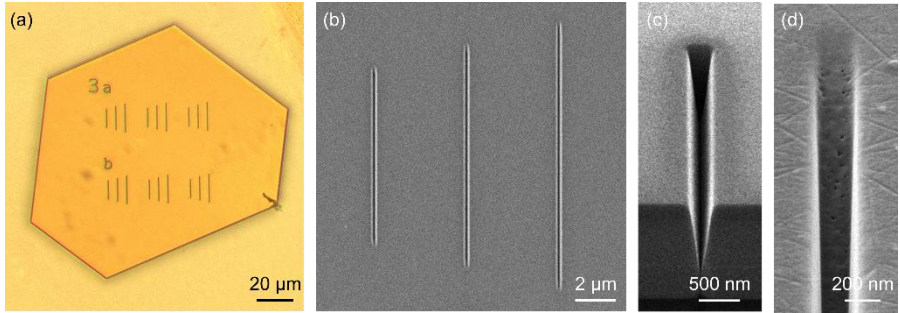


Fig. 1: (a) Microscope image of a gold flake containing V-grooves of different sizes. (b) HIM image of V-grooves. (c) HIM image of a cross-section of a V-groove together with a nano mirror. (d) HIM image of the nano-mirror at one of V-groove ends.