Monocrystalline silver flakes for applications in plasmonics

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Project Type: Master project

Context: Plasmonics – the subfield of nanooptics that studies light-matter interaction at metal surfaces – has found various applications in microscopy, sensing and optical communications over the recent years. However, performance of plasmonic systems is largely limited due to Ohmic losses at optical frequencies in noble metals. Reduction of these losses is a challenging task that can be addressed by employing crystalline materials that exhibit lower roughness and absence of structural defects. Chemically synthesized monocrystalline silver flakes are one of the promising candidates for such low-loss plasmonic material platform.

Project overview: At NAM laboratory, there are ongoing research projects that involve synthesis of noble metal flakes colloids and their subsequent nanopatterning. The student will work in collaboration with NAM researchers to develop the chemical synthesis procedure for silver flakes with large aspect ratio, as well as subsequent nanopatterning procedures. Furthermore, project will involve various nanostructure characterization methods as well as comparison against numerical simulations.

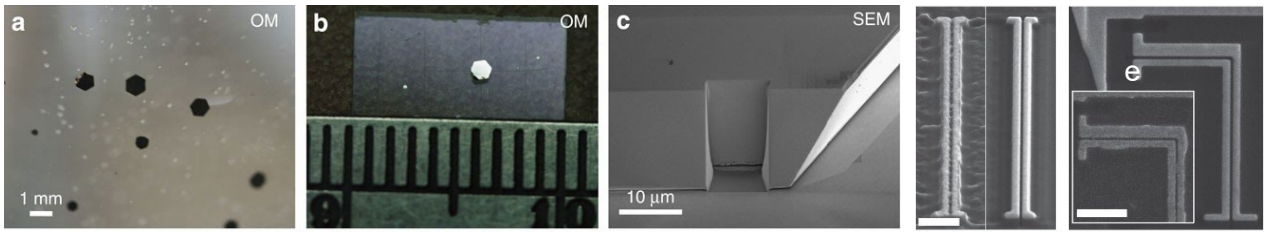

Figure. (a) and (b) optical microscope images of silver crystals; (c) SEM image of silver crystal corner. Images (a)-(c) are adopted from ref [1]. (d) and (e) SEM images of plasmonic nanostructures FIB-milled out of polycrystalline (sputtered) gold (left) and monocrystalline gold flakes (right); adopted from ref. [2].

What the student will do. The student will take part in the development of the colloidal synthesis procedure at the NAM chemistry facility, as well as cleanroom microfabrication work, subject to the needs of the project as it advances. The student will acquire practical experience following nanofabrication and characterization techniques.

- Colloidal crystal synthesis
- Optical microscopy and spectroscopy
- Scanning electron microscopy (SEM)
- Focused ion-beam (FIB) milling

Furthermore, student will learn the theoretical fundamentals of plasmonics and nanophotonics, and perform electromagnetic simulations of the plasmonic nanostructures using numerical tools available at NAM laboratory.

Benefits. Through this project, the student will gain a vast hands-on experience in checmical synthesis, characterization and nanofabrication techniques such as optical microscopy and spectroscopy, scanning electron microscopy and FIB patterning. Apart from practical aspects of the projects, student will acquire knowledge about the theoretical foundations of plasmonics and learn to numerically simulate optical response of metallic nanostructures. Successful implementation of the project may result in a contribution to a scientific publication.

References.

1. C.-Y. Wang, et al., "Giant colloidal silver crystals for low-loss linear and nonlinear plasmonics", Nature Communications, vol. 6, pp. 7734 (2015).
2. J.-S. Huang, et al., "Atomically flat single-crystalline gold nanostructures for plasmonic nanocircuitry", Nature Communications, vol. 1, pp. 150 (2010).