Post-Doctoral fellowship (2022-2024)

On-surface and protein-directed synthesis of ultrathin gold mesocrystals.

Starting date: As soon as possible **Duration:** 18 months (renewable)

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Site de Candidature*:* https://emploi.cnrs.fr/

A <u>multi-disciplinary</u> *(chemistry, biochemistry, microscopies)* ***<u>post-doctoral position</u> for an <u>experimental chemist</u>*** *is available in the Laboratoire Interdisciplinaire Carnot de Bourgogne (ICB, CNRS Univ. Bourgogne, Dijon, France) as part of a national collaborative research project gathering biochemists, physical chemists and cryo-electron-microscopists. The proposed work will be dedicated to the frontier field of* ***anisotropic Au single crystal synthesis****,* ***surface chemistry****,* ***protein engineering applied to material science*** *and advanced characterization using* ***optical spectroscopy*** *and* ***transmission electron cryomicroscopy****.*
The research project will comprise three parts: ***(i)*** *Development of new protocol for on-surface growth of ultrathin gold mesocrystals;* ***(ii)*** *surface functionalization with artificial proteins*[1] *and spectroscopic investigations;* ***(iii)*** *structural characterization of protein origami designed to template the growth*[2] *and assembly of optically active nanocrystals.*[3]

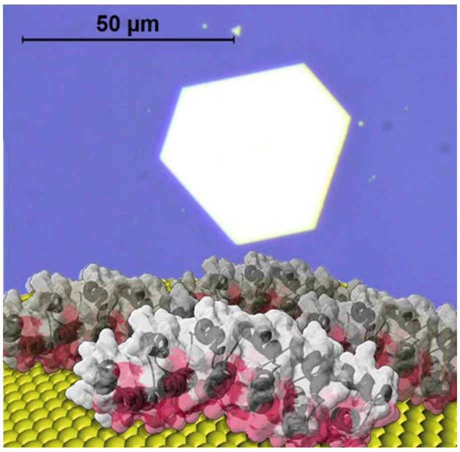
<u>Context:</u> Controlling the size, shape, interfaces and crystallinity of metallic nanostructures, in particular for plasmonic metals such as gold and silver, and mastering their coupling with other photo-active nanoparticles such as emitters, photocatalysts or photoactuators has expanded the scope of potential application fields of metal nanoparticles. Solution chemistry is now offering a variety of protocols to produce metal nanocrystals with well-defined shapes, size and surface chemistry. Yet two aspects remain challenging for their actual exploitation: (1) single crystallinity in anisotropic particles tends to be limited to a few micrometers and (2) the most effective chemical protocols rely on surface agents (surfactants, polymers) that irreversibly adhere to the metal surface and usually prevent further interfacial engineering.

<u>Objectives:</u> The proposed project will combine two concepts to produce and exploit macroscopic ultrathin 2D gold crystals with designable surface functionalization (Fig.1): (1) new on-surface synthesis protocols and (2) design and characterization of protein origami as a new type of growth templates. The mesocrystals produced during the project will rapidly be exploited in advanced photonic devices in our group.[4-6]

<u>Profile:</u> As a chemist, have you got a large expertise in noble metal nanoparticle synthesis and have you been trained in handling biomolecules? Have you acquired solid skills in chemical, structural and/or optical characterization techniques? Are you keen to developing new objects that triggers innovative interdisciplinary research?
If yes, this post-doctoral position will fulfill your expectations: apply and join our group!

The candidate ***will develop new on-surface protocols for producing ultrathin 2D Au mesocrystals*** *and perform* ***all structural characterization and some nanofabrication steps*** *in the ARCEN (ICB, Dijon) platform. The* ***protein origami*** *designed by our biochemist partners will be characterized by* ***TEM*** *and* ***cryoEM*** *in the CBI (Toulouse) facility and exploited as templates for the* ***morphosynthesis*** *of anisotropic Au/Ag crystals and the* ***assembly*** *with emitters. All structures and protein-metal interfaces will be characterized structurally (****AFM****,* ***TEM)*** *and* ***optically*** *(****TIRF****,* ***Raman****).*

<u>Pre-requisites:</u> Demonstrated skills and practice of gold and silver nanoparticle chemistry and physical chemistry and structural characterization (TEM, SEM, AFM, Raman) techniques are required. A good background in experimental biochemistry will be highly appreciated. Oral and written English level C1 is expected.
Provide emails of > 2 mentors who will write recommendation letters.



<u>Figure 1:</u> *Illustration of minimal size ultrathin 2D Au mesocrystal grown on glass and schematics of the artificial protein / Au(111) interface.*[3]

1 - Guellouz A., Valerio-Lepiniec, M., Urvoas, A., Minard, P., et al., **PloS One**, 8, e71512 (2013). (Link)
2 - J. Prasad, S. Viollet, K. L. Gurunatha, et al., P. Minard, E. Dujardin, **Nanoscale***,* 11, 17485-17497 (2019). (Link)
3 - M. Fernandez, A. Urvoas, P. Even-Hernandez, et al., P. Minard, E. Dujardin, V. Marchi, **Nanoscale**, 12, 4612-4621 (2020). (Link)
4 - S. Viarbitskaya, A. Teulle, R. Marty, J. Sharma, C. Girard, A. Arbouet, E. Dujardin, **Nature Materials**, 12, 426 (2013). (Link)
5 - A. Teulle, M. Bosman, C. Girard, K. L. Gurunatha, M. Li, S. Mann, E. Dujardin. **Nature Materials**, <u>14</u>, 87-94 (2015). (Link)
6 - U. Kumar, A. Cuche, C. Girard, S. Viarbitskaya, F. Dell'Ova, et al., A. Bouhelier, E. Dujardin, **ACS Nano**, 15, 13351-13359 (2021). (Link)