TOWARDS STABLE NANOALLOYS WITH PLASMONS IN THE UV RANGE

LABORATORY : Institut Lumière Matière
IN COOPERATION WITH : Mateis (INSA Lyon), LPS (Orsay)

LEVEL : M1 / M2
TEAM(S) : AGNANO

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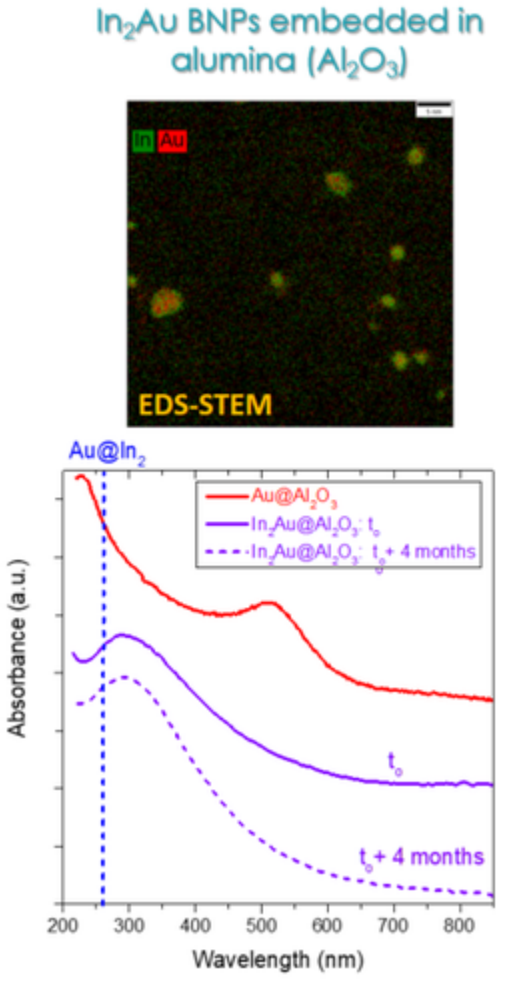
KEYWORD(S) :

SCIENTIFIC CONTEXT :

Mixing two metals at the nanoscale is an original way to create new nanomaterials with unique properties and potential applications in various fields (catalysis, optics…). These properties are closely related to their size, shape, composition and on their chemical structure, ranging from solid solutions to segregated phases such as core@shell structures. However, the underlying mechanisms of how the electronic and optical properties depend on the detailed structure (chemical composition and order, environment…) are far from being understood despite their crucial importance in both fundamental and applied science.

The aim of the joint research project is to fabricate well-defined BNPs and to study their structural and optical properties as a function of composition, chemical order and environment. NPs of noble or trivalent metals display strong resonances in the near UV-visible-IR spectral range, known as localized surface plasmon resonances (LSPRs), that are a sensitive fingerprint of their electronic structure. [1] The combination of the two different metals make it possible to tune this LSPR throughout the UV range, which is difficult to access today despite its importance in photocatalysis, hot electron generation or biosensing.

In this context, the structure and the optical response of BNPs combining gold or silver with aluminium or indium are investigated in order to examine if stable alloyed phases could exist and promote LSPRs in the UV range. [1, 2]



EDS-STEM image and optical response of InAu BNPs showing alloying and LSPR in the UV range

MISSIONS :

The BNPs are produced at the iLM's cluster source facilities, and then characterized by Transmission Electron Microscopy. The electronic properties of the BNPs can be deduced from optical spectroscopy, performed either on large ensembles or on single particles. All of these studies are carried out in a controlled atmosphere (environmental microscopy and optical spectroscopy) in order to ensure defined chemical states (oxidized vs. reduced).

The master student will participate in this collaborative work with several possible orientations to be discussed with the candidate. These include structural characterizations using TEM, optical spectroscopy together with simulations of their optical response (Mie theory), instrumental development and implementation. In any case, he/she will work in an experienced collaboration of several internationally leading research groups and will have the opportunity to learn cutting-edge experimental techniques at the forefront of experimental nanoscience.

OUTLOOKS :

The internship may lead to a further PhD.

BIBLIOGRAPHY :

[1] : A. Campos et al., Nature Physics 15, 275-280 (2019), https://doi.org/10.1038/s41567-018-0345-z.

[2] : Élise Camus et al. Eur. Phys. J. Appl. Phys. 97, 59 (2022), https://doi.org/10.1051/epjap/2022210298

[3] : Élise Camus et al., Faraday Discuss, 242, 478-498, (2023), https://doi.org/10.1039/d2fd00109h

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