Study of Cu_2O nanowire network junctions under different annealing for improved transparent p-type electronics

For the development of new efficient p-type TCO thin films as key step toward transparent electronic, the internship focuses on the understanding and enhancement of metal oxide nanowire networks, also called Nanonets.

Context
Transparent conductive materials (TCMs), derived from highly doped semiconductor materials, are widely used as electrodes in many applications (flat screens, touch screens, solar cells...). At present, however, the best electrical characteristics are obtained for compounds with n-type conduction, while those with p-type conduction have much lower conductivities and mobilities, particularly for integration on thermally sensitive and flexible substrates. This mismatch has several consequences: (i) it hinders the development of transparent hole-conducting thin films and (ii) it hinders the realization of p-n junctions or transistors that take advantage of the transparent semiconducting properties, whereas this would open the way to many applications in different fields [1]. In this context, and in order to break the bottleneck of transparent p-type semiconductor layers for applications on thermally sensitive and/or flexible substrates, the project aims at developing an innovative material concept based on the realization of a nanocomposite associating a thin film matrix of a transparent copper based p-type semiconductor oxide with a nanonet, a network of randomly oriented nanowires, of p-type semiconductor Cu_2O, so as to increase the performance in terms of figure of merit [2].

Project description
Within this context, the internship focuses on the study of the nanonet and their junctions using different annealing conditions (N_2, vacuum). The growth of those nanowires is achieved by a simple, eco-friendly synthesis and deposited randomly thanks to vacuum-filtering [3]. The electrical properties will then be analyzed using different characterization, to check the integrity of the structure (Raman, SEM, XRD) and the enhancement of the electrical properties, which can be done by *in-situ* measurements.

Scientific environment:
The candidate will work in the LMGP, Materials and Physical Engineering Laboratory, in the Synfoni team in close collaboration with CROMA in the CMNE team, a specialist in characterization and electrical properties of semiconductors. Located in the heart of an exceptional scientific environment, LMGP and CROMA offer the candidate a rewarding place to work.

Profile & requested skills:
The candidate is an engineering school and / or Master 1-2 student whose training focuses primarily on materials science. Aptitude for teamwork, good spoken and written English will be appreciated. We are looking for a dynamic, motivated and autonomous student.

Internship allowance: Internship allowance will be provided.
Duration : 3 – 6 months.
Application Deadline : 30th January 2026

CONTACT

Jean-Luc Deschanvres: jean-luc.deschanvres@grenoble-inp.fr; Tel: 04 56 52 93 34
Frédérique Ducroquet: frederique.ducroquet@grenoble-inp.fr; Tel: 04 56 52 95 24
Maxime Hanauer: maxime.hanauer@grenoble-inp.fr

References:
[1] Hu L, Wei RH, Tang XW, Lu WJ, Zhu XB, Sun YP. Design strategy for p-type transparent conducting oxides. Journal of Applied Physics 2020;128:140902. https://doi.org/10.1063/5.0023656.
[2] Bottiglieri L, Resende J, Weber M, Chaix-Pluchery O, Jiménez C, Deschanvres J-L. Out of stoichiometry CuCrO2 films as a promising p-type TCO for transparent electronics. Mater Adv 2021;2:4721–32. https://doi.org/10.1039/D1MA00156F.
[3] Belmouhoub M, Beitone S, Ternin-Rozat G, Braccini M, Deschanvres J-L, Rapenne L, et al. Ecofriendly Process to Synthesize Cu2O Nanowires with Tunable Morphology by pH Adjustments. Crystal Growth & Design 2025. https://doi.org/10.1021/acs.cgd.5c00360.