Flexible nanocomposite material as a transparent p-type semiconductor

Maxime Hanauer[1,2,*], Mouncif Belmouhoub[1,3], Soline Beitone[1], Xavier Mescot[2], Muriel Braccini[3], Fabien Volpi[3], Céline Ternon[1], Frédérique Ducroquet[2], Jean-Luc Deschanvres[1]

[1]Univ. Grenoble Alpes, CNRS, Grenoble INP, **LMGP**, 38000, Grenoble, FR
[2]Univ. Grenoble Alpes, Univ. Savoie Mont-Blanc, CNRS, Grenoble INP, **CROMA**, 38000, Grenoble, FR
[3] Univ. Grenoble Alpes, CNRS, Grenoble INP, **SiMAP**, 38000, Grenoble, FR
* maxime.hanauer@grenoble-inp.fr

Flexible all-oxides devices would allow the elaboration of low-cost solar cells for different applications, as in smart textile or building integration (windows, BIPV). Yet, the lack of p-type transparent conductive materials (TCO) with n-type counterparts' properties is a hindrance to effective transparent junctions. Current solutions, such as nickel oxide, copper iodide or organic materials (e.g., PEDOT: PSS) present interesting properties but impose compromises in term of stability and/or production cost.

In prior works, a $CuCrO_2$ film has been developed and optimized by AA-MOCVD [1]. By changing the precursor ratio, different phases and properties have been observed. At a certain composition, the deposition leads to the formation of a nanocomposite (NC) $Cu_2O/CuCrO_2$ presenting a resistivity of 0.2 Ω.cm. Holes density and mobility of $9.3 \cdot 10^{18}$ cm^{-3} et 0.65 $cm^2V^{-1}s^{-1}$ respectively, make this material interesting, needing further development and control.

The work presented here aims to perform a controlled NC using a Cu_2O nanowire (NWs) network, also called NanoNet (NN). These nanomaterials are formed through a sol-gel technique based on the Fehling test, which makes it a low-cost and environmental friendly synthesis. The NN geometry allows us to obtain a transparent film while keeping a high specific surface and good flexibility, thanks to the controllable form factor during the synthesis (Fig.1) [2]. Moreover, a NWs doping with magnesium has also been done (Fig.2) to reproduce the properties enhancement seen in thin films. This could increase the hole density and the bandgap, for a better conductivity and transparency respectively [3]. In the continuation, the NN will be encapsulated with a Cu-based TCO by AA-MOCVD to create the NC. Impact of NWs density and oxide stoichiometry will be studied to report optimal parameters. The final step will be to test different devices under mechanical stress.

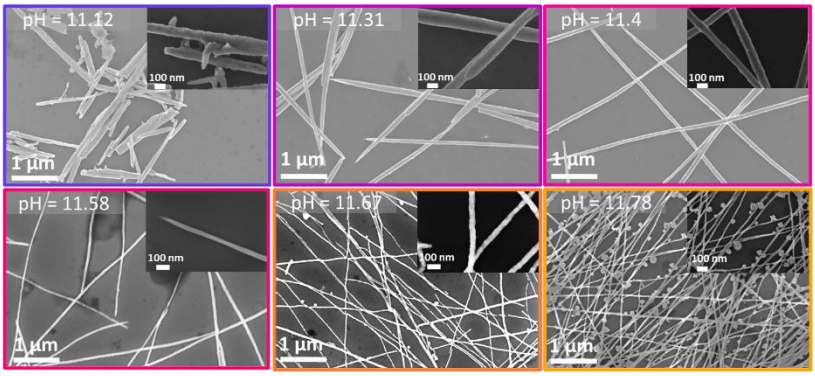

Fig. 1: Morphology of different NWs synthesized using various pH values, modifying the form factor [3]

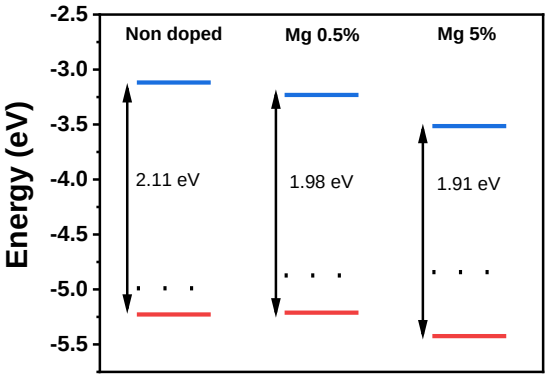

Fig. 2: Energy levels of Cu_2O NWs with different magnesium concentration in solution

[1] Bottiglieri L 2022 *CuCrO2 hors stoechiométrie comme semi-conducteur transparent de type p pour le photovoltaïque et l'électronique transparente* These de doctorat (Université Grenoble Alpes)
[2] Belmouhoub M, Beitone S, Ternin-Rozat G, Braccini M, Deschanvres J-L, Rapenne L, Riassetto D and Ternon C 2025 Ecofriendly Process to Synthesize Cu2O Nanowires with Tunable Morphology by pH Adjustments *Cryst. Growth Des.*
[3] Nolan M and Elliott S D 2008 Tuning the Transparency of Cu2O with Substitutional Cation Doping *Chem. Mater.* **20** 5522–31

This work is part of the ANR Nanocomposite (Projet-ANR-23-CE24-0012)