2023-2024 Doctoral position at LMGP and CROMA Lab.

Advanced nanocomposite materials as a solution for the development of flexible transparent electronics

Summary:

The thesis focuses on the development of an innovative nanocomposite material with a view to the development of new transparent and conductive P-type thin films as a key step towards the manufacture of transparent flexible electronic products..

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, etc.). However, at present, 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 thermosensitive and flexible substrates.

This mismatch has several consequences: (i) it hinders the development of transparent thin films that conduct holes and (ii) it prevents the creation of p-n junctions or transistors that take advantage of transparent semiconducting properties, which would open the way to numerous applications in different fields.

In this context, in order to break the bottleneck of transparent p-type semiconductor layers for applications on thermosensitive and/or flexible substrates, the thesis aims to develop an innovative material concept based on the elaboration of a nanocomposite combining a thin-film matrix of a transparent p-type semiconductor oxide based on copper 1+ oxide with a nanonet, a network of randomly oriented nanowires, of p-type semiconductor Cu_2O, in order to increase performance in terms of figure of merit.

Work description

The thesis work focuses on experimental aspects, starting with the development of nanonets and nanocomposites. In particular, the work will focus on optimising the growth of nanowires in order to control the form factor and electrical properties by studying different substitutions. The work will then focus on fully characterising the electrical behaviour of Cu_2O nanonets by correlating the results with the synthesis method used and analysing the contribution in terms of properties induced by the elaboration of the nanocomposite as a function, for example, of the deposition thickness of the thin-film matrix. During the thesis, it will also be interesting to study the mechanisms of charge transport, probably by percolation, in these new compounds. To this end, the work will draw on the morphological and structural characterisation resources at LMGP (SEM, AFM, XRD, Raman, etc.) and on the numerous electrical characterisations available at CROMA in the neighbouring Minatec building. For the study of the functional properties of nanocomposites, the PhD student will benefit from collaboration with SIMAP, also in Grenoble, to study the functional responses under various mechanical stresses, with in particular a system for electrical characterisation under mechanical stress implemented in situ in a scanning electron microscope.

Scientific environment:

The thesis will be carried out as part of the ANR Nanocomposite project. The candidate will work at LMGP Laboratoire des Matériaux et du Génie Physique, in the FunSurf team, in close collaboration with CROMA, a specialist in the characterisation and electrical properties of semiconductors.

Located at the heart of an exceptional scientific environment, the LMGP and CROMA offer candidates a rewarding working environment. LMGP and CROMA websites: http://www.lmgp.grenoble-inp.fr/ et https://croma.grenoble-inp.fr/

Salary : 2135€ gross/month Starting date : 10/1/2024

Researched Profile:

The applicant is a student at engineering school and/or Master's level whose training is mainly focused on materials science. Ability to work in a team and a good level of spoken and written English will be appreciated. We are looking for dynamic, motivated students.

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