

<b>Tytuł projektu</b>
<b>Synteza i badania nowych nanomateriałów na bazie azotku miedzi</b>
<b>Project title</b>
<b>Synthesis and characterization of new nanostructured copper nitride materials</b>
<b>Dyscyplina /Area of science</b>
Nauki chemiczne/Chemistry
<b>PROJECT DESCRIPTION</b>
<p><b>Project goals</b></p> <ul style="list-style-type: none"> <li>a) Preparation of new materials with useful physical properties, for applications in plasmonic holography, electronics or photovoltaics based on low dimensional copper nitride.</li> <li>b) Development of synthetic chemical methods of copper nitride nanostructured materials with a specific morphology (nanoparticles, nanorods, nanocrystalline layers and nanocomposites).</li> <li>c) Deposition of nanolayers by wet coating method such as spin- and dip- coating technique.</li> <li>d) Study of the relationships between the structure and physicochemical properties of the prepared materials.</li> </ul> <p><b>Outline</b></p> <p>The aim of the proposed project is to discover new materials with potentially useful physical properties, particularly with projected applications in plasmonic holography, electronics or photovoltaics. Copper nitride is an indirect band-gap (0.25 - 1.9 eV) semiconductor with a high electrical resistivity and a low reflectivity which can find potential application in the technology of optical storage, in photovoltaics, as a component of spintronic systems, as a potential conversion electrode material for rechargeable Li-ion batteries or in catalysis. <math>\text{Cu}_3\text{N}</math> is nontoxic and relatively stable in ambient conditions.</p> <p>Project is focused on preparation and characterization of new phases and new low dimensional copper nitride (<math>\text{Cu}_3\text{N}</math>) structures and to extend the methodology and materials design process to fabricate more compositionally complex materials taking copper nitride as</p>

a basis. The proposed project is in the field of basic research in inorganic chemistry and materials science. The new synthetic method will be implemented and optimized for simple way for the copper nitride fabrication. Understanding the relationship between the structure, physicochemical properties and the synthesis conditions will underpin the study. The main output of the project is the new knowledge on materials based on copper nitride and will give new data in the field of material science.

### **Work plan**

1. Synthesis of the starting precursors for copper nitride and utilizing them for nanostructured powders of  $\text{Cu}_3\text{N}$  fabrication.
2. Development of the intercalation methods of copper nitride.
3. Thin films deposition by wet chemical method, nanocomposites of  $\text{Cu}_3\text{N}$  preparation, and copper nanolines/nanodots fabrication.
4. Characterization of materials by SEM/EDX, TEM, AFM, X-ray diffraction, IR, Raman, XPS and thermal methods (TG,DTG/DTA). Examination of the optical properties of thin films and composites by Uv-Vis spectroscopy, ellipsometry and photoluminescence measurements.

### **Literature**

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- H. Wu, W. Chen; J. Am. Chem. Soc. 133(39) (2011), 15236-15239.
- T. Nakamura, H. Hayashi, T. A. Hanaoka, T. Ebina; Inorg. Chem. 53(2) (2014), 710-715.
- R. Deshmukh, G. Zeng, E. Tervoort, M. Staniuk, D. Wood, M. Niederberger; Chem. Mater. 27(24) (2015), 8282-8288.
- A. Jiang, et al.; J. Mater. Sci. Technol. 34(90) (2018), 1467-1473.
- R. Szczęsny, T. M. Muzioł, D. H. Gregory, E. Szlyk; Chem. Pap. 69 (4) (2015), 569–579.

### **Required initial knowledge and skills of the PhD candidate**

- ➔ Analytical thinking
- ➔ Analytical skills in solid state analysis
- ➔ Understanding of copper nitride chemistry
- ➔ Knowledge on nanotechnology, deposition techniques
- ➔ Understanding of basic chemistry, physics and materials science
- ➔ Experience in chemical synthesis

Zgłaszający projekt/ Author of the project	
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