

An Indian-Australian research partnership

Project Title:	Nanostructured Copper Devices Fabricated with Photon Curing	
Project Number	IMURA0502	
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Research Academy Themes:

Highlight which of the Academy's Theme(s) this project will address?

(Feel free to nominate more than one. For more information, see www.iitbmonash.org)

1. [Advanced computational engineering, simulation and manufacture](#)
2. Infrastructure Engineering
3. Clean Energy
4. Water
5. [Nanotechnology](#)
6. Biotechnology and Stem Cell Research

The research problem

Advanced nanoscale materials and their implementation in Flexible and Printed Electronic devices is expected to grow these markets from ~\$1B today to an estimated value of over \$73B by 2025 (IDTechEx). At the backbone of each of these technologies are metal based electrical conductors. Emerging devices such as plastic solar cells, OLED televisions and paper batteries are creating requirements on such conductive layers to be solution-processed, patternable and deposited at low temperatures (< 200 °C). To date, the only viable candidates to meet these requirements have been silver and gold nanoparticle inks. While such materials exhibit high electrical conductivity, chemical stability and are easily synthesized, they are also extremely expensive, which prohibits their viability in many future technologies.

Copper is an ideal alternative for many applications, provided that it can meet the required processing and electrical characteristics. The recent emergence of photonic curing has provided a viable pathway towards fabricating macroscopic copper electrodes at low temperatures and with nearly bulk conductivities. The application of photonic curing towards the development of nano and micro-structured copper features is significantly less developed, despite potential applications including high density circuit boards, next-

generation photonic devices, antennas and various nano/micro sensors. This project will focus on developing such structures using a variety of printing and coating techniques. Assisted by pulsed light and two-photon curing approaches, the goal of the work will be to understand the spatial limitations of photonic curing approaches and assess the use of such metallic structures within relevant device electronic architectures.

Project aims

To develop an understanding of copper based nanostructured materials suitable for photonic curing.
To assess the structural, electrical and optical properties of photonic cured copper structured using white light flash curing and IR two-photon absorption.
To explore nano/micro structured copper features as active components within electronic devices, e.g. as high density circuit boards, fine wire collector grids, 3D photonic architectures.

Expected outcomes

The Jasieniak group at Monash university are experts in nanomaterials for optoelectronics. They have developed copper based materials for macroscopic photosintering using white light flash curing.

Meanwhile, the Shukla group at IITB are experts in nanoparticulate materials and the development of photonic devices. One of the main capabilities that the group offers is in two-photon patterning of objects.

By working together, this project will push the spatial limits of photonic curing of copper based nanomaterials. Moreover, because both groups are experts in complimentary devices, these materials will be assessed within a variety of applications that naturally harness their high conductivity and spatial characteristics.

How will the project address the Goals of the above Themes?

Describe how the project will address the goals of one or more of the 6 Themes listed above.

Nanostructured materials are required to effectively enable photonic curing to be performed. In this work, we will develop relevant copper based nanomaterials utilizing colloidal and pyrolysis approaches. These materials will be used to develop photonic sintered architectures in 1D, 2D and 3D. By utilizing two-photon absorption processing of such structures, nanostructured length scales can be achieved. In doing so, this work will develop materials and devices that will bridge the nano to micro scales. Appropriate modelling of the sintering processes at these dimensions will be required to understand how to effectively develop optimized photonic sintered materials.

Capabilities and Degrees Required

List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.

Ideal candidate should have

1. Sound knowledge of Materials
2. Basic knowledge of Chemistry
3. Nanoparticle synthesis and characterisation experience, particularly colloid or through pyrolysis.
4. Laboratory Experience
5. Chemical Engineering, Materials Science and Engineering or Chemistry as major
6. A love for discovery!

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

Please provide a few key words relating to this project to make it easier for the students to apply.

Nanostructured Materials, Next-Generation Electronics, Nanoparticles, Printing.

