PROJECT DESCRIPTION

Supervisor France : Professeur El Hadj Dogheche / IEMN

co supevisor Singapour : Dr Jinghua Teng / Institut IMRE A*Star Singapour

Profil requested: Graduated Master Student with background in Physics / NanoMaterials

Scholarship : 1600 Euros / month (France) & 2800 SG/month (Singapore)

This research activity is focusing on Physics /Materials Engineering / Characterization of Materials / Application into Photonics.

With the rapid evolution of technologies, increasing needs in photonic devices is challenging. The novelty is actually based on the application of metasurfaces. The metasurfaces composing discrete subwavelength structures can impart full control of light wave in term of amplitude, phase, dispersion, momentum, and polarization. Flat optics made from metasurfaces have attracted huge attentions due to their versatile functionality, ultra-thin feature, and easiness for integration compared with conventional bulk refractive optics.

Many fascinating optical devices and functionalities have been demonstrated in the past decade. Active tuning the properties of metasurface would allow dynamic control of light wave, which has practical and fundamental significance in devices and applications e.g. radars as LiDAR 3D, Optical sensing and optical communication. In order to tune a metasurface, one needs to change the property of its underlying unit cells or its ambient, which could be done by employing active materials that can have their properties changed by external stimuli such as electrical, thermal, optical, magnetic, and mechanical.

Different types of materials have different properties and tuning mechanisms, and thus fits to different light wavelength range and applications. Among the various tuning mechanisms, electrical tuning has the advantage to make potentially compact optoelectronic system, besides other advantages on robustness and speed, and thus is the most attractive approach.

In this project, we will explore perovskite materials for electrically tunable metasurface. Due to the lack of center of symmetry in the crystal structure of perovskite materials (from ABO3 family), their electric polarization can be reversed by the application of an external electric field. The large linear electro-optical

effect, or the Pockel effect, in perovskite materials allows high tunability and linear control of the relative permittivity under applied electric field. We will explore and select the most suitable perovskite materials, study the perovskite thin film growth by physical vapor deposition such as Sputtering, conduct through materials characterization on ferroelectricity and electro-optical effect, and produce high crystal quality perovskite materials for tunable metasurface and metadevice fabrication and demonstration.

Scope of work in France

@ University UPHF France

- Deposit perovskite films by sputtering and also nanostructures by soft chemical (hydrothermal).
- Characterize the properties of the materials (tunability, ferroelectricity, piezoelectricity, EO)
- Optimize the film composition to required film properties
- Valorization of results / publications / conferences + PhD manuscript writing and Oral defense

Scope of work in Singapore

@ A*STAR Singapore

- Perovskite thin film deposition and characterization
- High quality perovskite material growth into tunable metasurface structure
- Demonstration of tunable metasurfaces and metadevices
- Valorization of results / publications / conferences