

ONERA

THE FRENCH AEROSPACE LAB

The dielectric function of 2D materials and its role in secondary electron emission

PhD project, methods and objectives

ONERA's DPHY department is studying the effects of cosmic radiation on space vehicles, in partnership with industries and agencies such as CNES and ESA. The Multipactor effect is a damaging process of electrical discharge that can be triggered in the Radio Frequency (RF) components of satellites. The secondary electron emission is one of the main causes of Multipactor damaging. One way to limit secondary emission is to deposit low electron emitting materials on the surface of waveguides. Graphite is known for its good characteristics but 2D graphene films are expected to be even more efficient.

The secondary electron emission is the consequence of the interactions of the incident electrons with the electrons of the irradiated solid. The complex dielectric function represents the response of a material to electromagnetic excitation, i.e. to the impact with a charged particle such as an electron. Therefore, the aim of the PhD project is to study and understand the link between the complex dielectric function of specific materials and their electron emission capacity. For this purpose, two types of simulation tools will be used. Ab-initio calculations (DFT and TDDFT) will be performed to simulate the dielectric function. The modelling of the secondary electron emission process will be carried out using an electron transport code developed at ONERA and based on the Monte Carlo method. The parameters of the latter simulation as the electron-electron interaction cross-sections will be determined by prior ab-initio calculations.

The objective of the study will be to understand what characteristics of graphene makes it particularly low-emissive. The work will mainly consist of analysing the results of ab-initio and Monte Carlo simulations, but will also be based on experimental measurements from the literature or carried out in associated laboratory.

Location

Two thirds of the project will be hold in the ONERA laboratories in Toulouse, France and one third in the ONERA site in Châtillon, in the suburbs of Paris, France.

Thesis director: Christophe Inguibert (ONERA, Toulouse)

Thesis co-director: Lorenzo Sponza (ONERA, CNRS, Châtillon)

Key words: Modelling, secondary emission, complex dielectric function, ab-initio, Monte Carlo

Profile and skills required

The candidates must have a degree in Physics and/or engineering School and possess knowledge of general physics, solid state physics, materials physics. Knowledge of the dielectric function of materials would be a plus. The project is mainly theoretical and the student must have a strong interest in modelling.

Typical schools and training courses: General Physics, Material Science, Solid state physics, Physical modelling. Engineering schools (INSA Lyon, Toulouse, Polytech, Telecom Physique Strasbourg, PHELMA,

Begin of the Ph.D.: 2023

Deadline for submission: mars 2023

Submission: Send your Curriculum Vitae, a motivation letter and at least one referee contact to christophe.inguibert@onera.fr and lorenzo.sponza@onera.fr