Can we use graphene as a conversion surface for a neutral particle detector?

Alexander Grigoriev, Andrei Fedorov, and Nicolas André
IRAP-UPS-CNRS, Toulouse, France

An important technique of modern space plasma diagnostics is the detection and imaging of low energy (below 10 keV) energetic neutral atoms (ENA). Any space mission devoted to study of the planetary plasma environments, planetary magnetospheres and heliosphere boundaries, needs a low energy ENA imaging sensor in its payload list. A common approach to the ENA detection/imaging is to make energetic neutral atoms glance a high quality conductive surface and either produce a secondary electron, or produce a positive or negative reflection ion. In the first case we can collect and detect the yielded secondary electron and generate a start signal. The reflected neutral atom can be directed to another surface with a high secondary electron yield. Thus we can measure a time-of-flight of the reflected particle to get its velocity. In the second case we can analyze the reflected ion in an electrostatic analyzer to get the particle energy.

Many types of conversion surfaces have been investigated over last decades in order to optimize an ENA sensor properties. We investigated properties of a thin layer of graphene applied to a silicon wafer surface. The experimental setup consisted of a secondary electron detector, neutral/ions separator and a high resolution particle imager. We used an incident He beam with energy of 200 eV - 3000 eV. We obtained a secondary electron emission, particle reflection efficiency, scattering properties, and a positive ion production rate as a function of the incident beam energy and the grazing angle. The experiment results show that 1) Graphene is a good source of secondary electrons even for low energy incident particles; 2) ENA scatter from the graphene surface similar to other surface types; 3) Graphene does not convert incident ENA to positive ions, especially for high grazing angles.