Novel nano-materials as candidates for modern radiation detectors

新しい放射線検出器の候補としての新規ナノ材料
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Detectors for X-rays, ions and electrons play an important role in both science and industry. During the past 50 years, methods of detection and measurement of ionizing radiation have undergone a significant evolution with new detectors frequently based on newly developed materials and technologies such as diamond, high purity germanium, and Peltier cooling of the devices.

The secondary electron emission (SEE) yield of heterostructures of ZnO nanoneedles coaxially coated with AlN or GaN has been studied for the first time using electron, ion, and X-ray beams. The SEE yield of the heterostructures is enhanced significantly by the intrinsic nanostructure of the ZnO nanoneedle templates as compared to the AlN and GaN thin films on Si substrates. These findings open up a way to develop new universal highly efficient radiation detectors based on the SEE principle by incorporating these one-dimensional (1D) nanostructures as a material of choice.

A similar idea was previously developed for carbon foils, boron-doped diamond and is now proposed for nanomaterials. Series of experiments have been performed with different radiation including electrons, ions and X-rays to better understand processes governing the SEE in 1D nanostructured materials. This talk will describe our work towards a new class of detectors for radiation. So far two international patens have been awarded for these works.

We are proposing an application for further support of research from Horizon 2020 in Europe. The proposed project will enable us to investigate the properties of a secondary electron emission (SEE) from a new generation of nano-materials under irradiation from ions, electrons, X-rays and photons. This has a huge number of potential applications, including development of new class of radiation detectors. This project will demonstrate both the innovation as well as significant industrial involvement. This project will involve scientific groups from Australia, France, Germany, Japan, Poland, UK and Ukraine.

和訳概要

放射線検出器は、科学と産業に重要な役割を果たしており、過去 50 年で、ダイヤモンドなどを含む材料や冷却技術の開発によって顕著な進歩を遂げている。今回は新規ナノ材料を用いた 2 次電子放出による新しい検出技術について紹介する。
AlN または GaN で同軸状にコーティングされた ZnO ナノ針のヘテロ構造による電子、イオン、および X 線ビーム照射に対する 2 次電子放出（SEE）収量について初めて測定された。この結果ヘテロ構造による SEE 収量は、Si 基板の AlN や GaN 薄膜でコーティングした Si 基板に比べてそのナノ構造によりかなり強化される。このような一次元の（1D）ナノ構造を含んでいる新しい材料での高効率 SEE に関する発見は非常に高効率な検出器開発の可能性をもたらしている。
講演では国際特許を取得したこの新しい概念に基づく検出器開発に向けた取り組みを紹介する。なお、一連の研究プロジェクトについては欧州の研究開発・イノベーションプログラムに応募している。