MSc / PhD Project Outline – Department of Physics – University of Warwick

Advanced photocathodes integrated with gaseous electron multipliers

This experimental project is suited to either M.Sc. or Ph.D. study. The project combines thin-film and surface physics with charge transport and multiplication in inert gas at atmospheric pressure. It is a collaborative endeavour with Dr. Yorck Ramachers of the Elementary Particle Physics Group. We also collaborate with several UK companies, with the Accelerator Science and Technology Centre at Daresbury Laboratories, and with the Environmental Engineering department at Monash University in Australia. *Additional funding may be available to support a research visit to Australia for both M.Sc. and Ph.D. students.*

Photocathodes are materials which emit electrons after absorbing light: they can be used in a wide range of sensor and communications applications as well as in accelerators, where bunches of electrons are generated by laser pulses. Accelerators are important for particle beam therapy (healthcare) as well as material analysis for e.g. advanced manufacturing and energy applications. We have also demonstrated a sensor application for water quality monitoring [1]. The photocathodes are integrated with gaseous electron multiplier (GEM) structures, invented originally at CERN and now further developed at Warwick. The student will work on simulations and/or physical construction & testing of unique GEM devices. These will incorporate our customised photocathodes, giving potentially very high performance devices with large surface area, low cost and tuneable response.

Two key parameters of a photocathode are its work function, the energy barrier which electrons must overcome to escape the material, and its quantum efficiency, the number of electrons liberated per incident photon. Our water sensors and accelerator photocathodes have very different requirements, with wavelength cutoffs ranging across the ultraviolet spectrum. The geometry and environment of the photocathodes also vary (e.g. ultra-high vacuum in accelerators vs. atmospheric pressure inert gas in our sensors). We tailor different thin-film materials to these applications, including materials devised through computational materials design via density functional theory. The photoemission process is strongly influenced by the surface of the photocathode. You will learn to grow thin films of several photocathode materials and use surface modification techniques to optimise their photoemissive properties, e.g. formation on single atomic bilayer MgO on metal photocathodes [2]. During the current collaboration we have developed facilities in Warwick for thin-film growth with rapid analysis (surface chemical analysis, work function, quantum efficiency, responsivity) and will exploit this unique research infrastructure in the studentship.

Extensive hands-on training and support in thin film growth and surface science will be provided along with a range of taught postgraduate modules tailored to your needs.

For further information and to apply, please contact Gavin Bell gavin.bell@warwick.ac.uk and Physics Postgraduate Admissions. The project will suit candidates with a strong background in physics, physical chemistry or engineering.

[1] Ultraviolet absorption of contaminants in water, Sci. Rep. **11** 3682 (2021).
[2] Photocathode performance characterisation of ultra-thin MgO films on polycrystalline copper, J. Phys.: Conf. Ser. **2420** 012032 (2023).