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Sources Interaction with Matter, Detection and Analysis of Low Energy Electrons

Low Energy Electrons (LEE), how to create them, how to get rid of them, how to control them? Surprisingly, a subject in physics which is over a hundred years old, nowadays still poses challenges that are discussed in the community in a highly controversial fashion. In this connection, consider for example the simplest conceivable question one could ask regarding the emission of slow electrons from solid surfaces: *if one were to put a single electron with a certain kinetic energy inside a solid, how many will be ejected from the surface as a result?* This essentially simple question of the Secondary Electron Yield (S.E.Y.) still awaits resolution.

On the other hand, low energy electrons play an increasingly important role in many modern applications. A prominent example is the secondary electron microscope where SEs are utilized to visualise nanostructured materials. More generally, for the analysis of surfaces low energy electrons are of increasing importance, as exemplified in a most impressive way by recent developments in the field of Low Energy Electron Microscopy (LEEM). In many types of spectroscopy, materials with a high secondary electron yield are employed for detection of charged particles, whereas, in the same instrument, secondary electron emission in the particle optics is usually highly undesired. Low-energy SE may dramatically affect high-energy physics accelerators and storage rings through the multipacting phenomenon. There, formation of an electron cloud may critically affect the heat load to be dissipated away in the cryosystems cooling superconducting magnets. Similarly, the plasma-wall interaction in a fusion reactor is mediated by the electronic emissivity of the reactor walls. SE emission also plays a crucial role in the energy and charge balance of gaseous electronics such as plasma display panels. Charging of surfaces in spacecrafts induced by cosmic radiation can critically affect their operation and lifetime.

Even if the slow electrons in question are not emitted from a surface but are created in the form of hot electrons, i.e. if their final state energy is below the vacuum level, they play an important role in many applications. In life sciences LEE are often the final product of ionising radiation interacting with biological tissue which actually induces DNA-damage. Hence the interaction of low energy electrons with matter is important for understanding tumour formation, but also, and even more importantly in the future, for therapeutic applications. Similarly, in semiconductor technology, in particular with the advent of EUV-lithography, the diffusion of LEE in matter represents a limiting factor due to this proximity effect. Likewise, in Focused Electron Beam Induced Deposition LE-SEs play an important role in the manufacturing process of microelectronics and finally, hot electrons are exploited in photovoltaic devices.

It is clear from the above that a number of fundamental questions regarding LEE need to be resolved in the framework of a broad scientific effort in order to advance the applications mentioned above. The relevant fields and applications are all expected to have an increasing impact in the future not only scientifically, but also economically ultimately leading to beneficial innovations. This was recognised by the European Commission in granting the research proposal SIMDALEE2 (Sources, interaction with Matter, Detection and Analysis of Low Energy Electrons, Grant No. PITN 606988). The research and training network which was established on this basis has not only lead to significant progress in this field, but also served as a starting point of the career of 14 highly motivated young talented people under the supervision of European experts. The present issue brings together the contributions of the Marie Sklodowska-Curie fellows of the above project as well as a number of renowned specialists in various fields related to these subjects using different approaches and focusing on different aspects such as Secondary Electron Emission and Electron-Solid Interaction, Correlation Spectroscopy on Surfaces using electron pairs, Photo- & Field-Emission, Electron Microscopy and Spectroscopy Scanning Probe Microscopy, Nanotechnology and Biomaterials, their Interaction with LEEs as well as Spin and Magnetism.

This Volume is recommended for readers interested in following the developments in the fields addressed above. The work done by the authors of each contribution is gratefully acknowledged as is the support by the European Union which made the realisation of this endeavour possible. Finally, two individuals whose names would otherwise go unprinted in the present volume deserve to be acknowledged here: the SIMDALEE2 project officer Vojko Bratina, and the management coordinator Ernst-Dieter Janotka.

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