Fundamental Physics for Plasma Technology

Uwe Czarnetzki

Faculty of Physics and Astronomy, Ruhr University Bochum, Germany
e-mail: uwe.czarnetzki@rub.de

In applied physics, systems are investigated that are manmade and that serve a certain application purpose, particularly in industrial production. This general setting of the scene brings with it a well justified trend of focusing the aim of scientific investigations on the improvement of basic processes or the understanding of very specialized questions within a particular system. Fundamental physics on the other hand is mostly understood as searching for the basic laws of nature free of any immediate application. However, in this presentation it will be argued that with a wider understanding of fundamental physics it is indeed important for further development of applications and can have immediate or at least mid-term impact. This statement seems to be supported particularly by the fruitful relation between plasma physics and plasma technology. The field has been exceptionally successful e.g. in the development of the semiconductor and micro-mechanics industries, surface treatment in role-to-role processes, thin solar cells, and many other applications, including recently so diverse fields as plasma medicine and agriculture and plasma thrusters for space applications.

Despite this apparent success in developing the field, there can be no doubt that in the past as well as in the present real major leaps have always required new insights from fundamental physics. In the presentation the argument will be developed further by some selected examples. The basic concepts will be presented and possible implications discussed. This includes the famous discovery of synergistic etching by Coburn and Winters in 1979 at IBM [1], the so called electrical asymmetry effect for RF plasma generation and bias control [2], a new collisionless electron heating concept called INCA [3], and a new concept for describing low-pressure plasmas kinetically [4]. A quote from the 2017 Plasma Roadmap [5] might serve as a resume: “The field of low temperature plasmas is exceptionally interdisciplinary with grand-challenge level scientific questions that have a dynamic range that is perhaps greater than any other field of physical science.”

REFERENCES:

[1] J. W. Coburn and H. F. Winters, J. Vac. Sci. Technol. 16, 391 (1979).

[2] Brian G Heil, Uwe Czarnetzki, Ralf Peter Brinkmann and Thomas Mussenbrock, J. Phys. D: Appl. Phys. 41, 165202 (2008)

[3] Ph. Ahr, T.V. Tsankov, J. Kuhfeld, U. Czarnetzki, Plasma Sources Sci. Technol. 27, 105010 (2018).

[4] U. Czarnetzki, Plasma Sources Sci. Technol. submitted (2019).

[5] I Adamovich et al., J. Phys. D: Appl. Phys. 50, 323001 (2017)