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Research trends in high-frequency technological plasmas: the importance of understanding the fundamentals[1]

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Plasma technology utilizing high-frequency sources has tremendous effects on society via assisting the development of modern electronic circuits, photovoltaic devices, medical implants and techniques, etc. The talk will address the question how deeply do we really understand the physics of these plasma sources? It will be shown that, in contrast to common belief, a variety of fundamental aspects is not well understood. As new experimental, theoretical and simulation approaches result in significantly deeper insights, aiding both the advance of physics and the optimization of the manifold applications, some misconceptions and new fundamental research questions could be revealed recently. Examples related to electron power absorption, charged particle dynamics, and the formation of particle distribution functions will be discussed. Efficient, knowledge-based control of these characteristics, e.g., by using hybrid plasma sources and/or voltage waveform tailoring has been shown to be possible, and represents an emerging research field in plasma technology. A synergistic combination of state of the art experimental techniques and high-performance computations (based on validated models and verified codes) can lead to another level of understanding of these plasma sources. Experimental approaches provide now access to time resolution well within the radiofrequency excitation periods. Numerical modeling extended to 2D or 3D allows a description of practical plasma sources in the important operation regime where kinetic effects prevail. Modeling relies, however, on elementary data on gas-phase and surface coefficients of which the knowledge is of key importance for obtaining accurate results, particularly in complex and application relevant gas mixtures.

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