Plasma-nano-interface: from plasma-for-nano to nano-plasmas

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This presentation reviews and highlights the key aspects of progress achieved in plasma nanoscience research over the last dozen years. The advances made and the knowledge base created is critically examined through the prism of the fundamental framework structured along the key fundamental questions: (1) what happens when low-temperature plasmas face a solid object of nanoscale dimensions [1] and (2) is it possible to reduce the plasma size to the nanoscales, similar to other (solid, liquid, and gas) states of matter [2]?

These fundamental questions are at the foundations of plasma nanoscience. The answers lead to better understanding of many unique and interesting physical and chemical effects that could be generated through such nanoscale localizations of multi-phase interactions at plasma-solid interfaces under extreme non-equilibrium conditions.

Many synergistic (1 + 1 >2) effects appear through these interactions at the plasma interface. These effects enable several advanced applications of low-temperature plasmas in micro- and nanofabrication, nanoscale materials synthesis and processing, industrial catalysis, new sustainable industrial processes based on green-chemistry approaches. Many exotic effects appear when plasma size is reduced into nanometre domain. The examples are: plasma-nano catalysis [3], sustainable nanotechnology [4], nanoscale plasma-surface interactions [5], and nano-plasmas generated by intense radiation [2].

The presentation will conclude with some examples of using plasma, thermal, ionic and other processes to control macroscopic properties of materials by precise manipulations of atomic bonds, atoms and defects at nanoscales and the opportunities for industrial applications and entrepreneurship [6], and the challenges and cross-disciplinary platforms such as plasma-materials informatics on the way materialize these ambitious goals.

[1] K. Ostrikov, Rev. Mod. Phys. 77, 489 (2005)

[2] K. Ostrikov, F. Beg, and A. Ng, Rev. Mod. Phys. 88, 011001 (2016)

[3] E. C. Neyts, K. Ostrikov, et al. Chem. Rev. 115 (24), 13408–13446 (2015).

[4] K. Bazaka, J. Mohan, and K. Ostrikov, Chem. Rev. 116 (1), 163–214 (2016).

[5] K. Ostrikov, E. C. Neyts, and M. Meyyappan, Adv. Phys. 62, 113 (2013)

[6] D. H. Seo,…, and K. Ostrikov, Nature Comm. 8, 14217 (2017); Nature Comm. 9, 683 (2018).