2nd Asia-Pacific Conference on Plasma Physics, 12-17,11.2018, Kanazawa, Japan

Shrinking the plasma: why not the pores?

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This presentation focuses on the advances in the plasma nanoscience area over last decade and the knowledge base created. The key focus of this talk is on posing and critically examining two key fundamental questions, the cornerstones of plasma nanoscience, the questions that the multidisciplinary plasma nanoscience community has been trying to answer in the last decade, namely:

- what happens when low-temperature plasmas face a solid object of nanoscale dimensions [1]
- is it possible to reduce the plasma size to the nanoscales, similar to other (solid, liquid, and gas) states of matter [2]?

Furthermore, we will examine the extremely interesting point on what unique and interesting physical and chemical effects one could produce through these localized interactions at plasma-solid interfaces?

This time we will also examine a new question:

- can nanoscale interactions of charged particles such as ion beams be used to actually shrink some features like pores, and to bring them down to low-nanometer dimensions [3].

Interestingly, these interactions at the plasma interface lead to the many synergistic effects which in turn appear useful in the applications of low-temperature plasmas for nanoscale synthesis and processing, catalysis, development of sustainable green-chemistry-based industrial processes, and in the attempt to harness unique and exotic effects when attempting to reduce the size of plasmas down to nanometer domain. Some of the examples of these synergistic effects are related to plasma-nano-catalysis [4], sustainable, green-chemistry based nanotechnology [5], and nano-plasmas generated by intense radiation [2]. The most relevant plasma interfacial phenomena will be discussed, e.g., synergistic effects of the plasmas and nanoscale catalysts that may potentially lead to value-added products. The relevant physical limitations in the approach to generate nanoplasmas (can the plasma go nano?) will be introduced to help evaluate some of the possibilities to generate such plasmas and discuss the relevant transient and highly non-equilibrium phenomena. We will also discuss and interpret related effects owing to nanoscale plasma-surface interactions, as well as size-dependent and other intriguing nanostructure properties [6]. 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, atomic and defect migration processes at nanoscales and the opportunities for industrial applications and entrepreneurship [7,8], and the many challenges and enabling cross-disciplinary platforms such as plasma-materials informatics on the way materialize these ambitious goals.

References

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

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

[3] M. Aramesh et al., ***Nature Comm.*** 9, 835 (2018)

[4] E. Neyts et al., ***Chem. Rev.*** 115, 13408 (2015)

[5] K. Bazaka et al., ***Chem. Rev.*** 116, 163 (2016)

[6] K. Ostrikov et al., ***Adv. Phys.*** 62, 113 (2013)

[7] D. H. Seo et al., ***Nature Comm.*** 8, 14217 (2017)

[8] D. H. Seo et al., ***Nature Comm.*** 9, 683 (2018)