Interfacing Microplasmas and Microplasmas for Nanomaterials Interfaces

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Abstract— **Nanomaterials have demonstrated to possess properties that are highly desirable for a wide range of applications. The successful integration of nanomaterials in many application devices strongly depends on our ability to accurately synthesize materials with the necessary properties, i.e. with given size, morphology, material composition, crystal structure and surface characteristics. In particular, surface characteristics play a key role in determining properties and functionalities of nanoparticles that have typical dimensions below 10 nm. It follows that the synthesis of nanomaterials has to include a process for surface engineering which can be simultaneous to the nanomaterial growth or as part of a post-growth treatment. In this context, atmospheric-pressure microplasmas (AMPs) have shown the capabilities of synthesizing nanomaterials with the required characteristics [1-4] and with additional opportunities for surface engineering [5]. AMPs present unique features that differentiate them from other types of plasmas [1, 6-8]. Therefore, AMPs can provide new synthetic avenues not achievable with other techniques such as chemical synthesis or lowpressure plasmas.**

In this contribution we will initially provide an overview of microplasmas properties and capabilities in nanomaterial synthesis [2, 3, 9] and then focus on two specific AMP systems. The first AMP system is based on a gas-phase approach for the synthesis of multi-components nanoparticles. In the second system, a microplasma generated at the surface of a liquid solution (e.g. water, ethanol) is used to induce low-temperature liquid-based non-equilibrium chemistry and therefore synthesize nanoparticles and/or promote their surface functionalization [6]. Silicon, silicon alloys, gold nanoparticles and graphene (figure 1) are examples of nanomaterials that have been successfully synthesized and/or surface engineered with these AMPs. Finally details on the plasma-induced mechanisms that contribute to the synthesis/surface engineering in AMPs will be discussed and future prospects will be also outlined.

REFERENCES

[1] Mariotti, D; Sankaran, RM Journal of Physics D: Applied Physics 43 (2010) 323001
[2] Mariotti, D; Ostrikov, K Journal of Physics D: Applied Physics 42 (2009) 092002
[3] Mariotti, D; Lindstrom, H; Bose, AC; Ostrikov, K Nanotechnology 19 (2008) 495302
[4] Levchenko, I; Ostrikov, K; Mariotti, D; Švrček, V Carbon 47 (2009) 2379
[5] Švrček, V; Mariotti, D; Kondo, M Applied Physics Letters 97 (2010) 161502
[6] Mariotti, D; Sankaran, RM Journal of Physics D: Applied Physics 44 (2011) 174023
[7] Mariotti, D; Shimizu, Y; Sasaki, T; Koshizaki N. Applied Physics Letters 89 (2006) 201502
[8] Mariotti, D; McLaughlin, JA; Maguire, P Plasma Sources Science & Technology 13 (2004) 207
[9] Shimizu, Y; Bose, AC; Sasaki, T; Mariotti D; Kirihara K; Kodaira T; Terashima K; Koshizaki N, Transactions of the Materials Research Society of Japan 31 (2006) 463