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Cluster Issue on Microplasmas

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EDITORIAL

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Atmospheric-pressure diffuse discharge plasmas are susceptible to instabilities and, in particular, to arcing (the glow-to-arc transition). Some of the most promising approaches to 'stabilizing' atmospheric-pressure plasmas are based on the recognition that arc formation can be avoided when the plasmas are generated and maintained in spatially constricted geometries with dimensions from tens to hundreds of microns. Known as microplasmas or microdischarges, these weakly-ionized discharges represent a new and fascinating realm of plasma science in which several scientific issues, such as the potential breakdown of pd scaling and the role of boundary-based phenomena, come to the fore. In contrast to 'macroplasmas' typically produced at pressures well below one atmosphere, high-pressure microdischarges offer the formation of transient molecular species, such as the rare gas excimers, that are generated by three-body collisions. When excited with sub-microsecond pulses, microplasmas can exhibit significant shifts in electron and ion temperatures and in the electron and ion energy distribution functions, which can be exploited in applications such as intense UV/VUV light sources and for the selective production of chemically reactive radicals. The technological applications of these stable high-pressure microplasmas have outpaced the detailed understanding of the plasma physics and the key processes in these plasmas on a microscopic level.

In February 2003, Professor K Tachibana organized a workshop in Japan entitled 'The New World of Microplasmas', which, for the first time, devoted an entire conference to the exciting new scientific challenges and emerging technological opportunities for microplasmas and microdischarges. The 'Second International Workshop on Microplasmas (IWM-2004)', organized by K H Becker, J G Eden and K H Schoenbach, was held on 6–8 October 2004 at the Stevens Institute of Technology in Hoboken, NJ, USA. IWM-2004 attempted to (i) summarize recent scientific achievements in the area of microplasmas and microdischarges, (ii) highlight current applications, and (iii) identify future scientific challenges and technological opportunities in this field.

Three invited plenary talks, 15 invited progress reports, and 32 contributed papers addressed basic plasma physics aspects relevant to microplasmas and microdischarges, such as experimental, theoretical, and computational studies devoted to the determination of electron and ion energy distribution functions and temperatures, species concentrations, and I–V characteristics, as well as to a wide range of technological applications of microplasmas and microdischarges. In addition, one afternoon was devoted to a symposium entitled 'Environmental, Biological, and Medical Applications of Microplasmas', which was organized and sponsored by the Center for Environmental Systems (CES) at Stevens Institute of Technology and featured five invited talks and five contributed papers.

All participants at IWM-2004 were invited to submit original research papers based on their presentations to this cluster issue of *Journal of Physics D: Applied Physics*. Devoted entirely to microplasmas, this cluster issue is intended to provide the reader with a sense of the scientific energy and anticipation that characterized IWM-2004. It contains an excellent cross-section of papers describing advances in experimental, theoretical, and computational research

efforts to furthering our understanding of microplasmas and the processes and mechanisms that determine their properties and highlight their impact on a growing number of applications in materials processing, displays, and medical diagnostics, to name just a few.