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Electric discharge microplasmas generated in highly fluctuating fluids: Characteristics and application to the synthesis of molecular diamond[1]

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Plasma-based fabrication of novel nanomaterials and nanostructures is paramount for the development of next-generation electronic devices and for green energy applications. In particular, controlling the interactions between plasmas and materials interfaces, and the plasma fluctuations are crucial for further development of plasma-based processes and bottom-up growth of nanomaterials. Discharge microplasmas generated in supercritical fluids represent a special class of high-pressure plasmas, where fluctuations on the molecular scale influence the discharge properties and the possible bottom-up growth of nanomaterials. In the first part of the talk, we will discuss an anomaly observed for microplasmas generated near the critical point, a local decrease in the breakdown voltage, which has been observed for both molecular and monoatomic gases. This anomalous behavior is suggested to be caused by the concomitant decrease of the ionization potential due to the formation of clusters near the critical point, and the formation of extended electron mean free paths induced by the high-density fluctuation near the critical point. We will also show that when generating microplasma discharges close to the critical point, that the high-density fluctuation of the supercritical fluid persists. In the second part of the presentation, we will first introduce the basic properties of diamondoids and their potential for application in many different fields - biotechnology, medicine, opto- and nanoelectronics - before discussing their synthesis by microplasmas generated inside both conventional batch-type and continuous flow reactors, using the smallest diamondoid, adamantane, as a precursor and seed. Finally we show that one possible growth mechanism of larger diamondoids from smaller ones consists in the repeated abstraction of hydrogen terminations and the addition of methyl radicals.

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