

The role of gas kinetics and surface interaction probabilities in simulations of industrial plasma sources at low pressure

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Non-thermal plasmas produced at low pressure are commonly used in a wide variety of industrial processing applications such as the etching and deposition of nano-scale structures in the semiconductor industry, systems for electric propulsion of spacecraft and negative ion sources for the heating of fusion-relevant plasmas. In many applications the design of processes or plasma sources is informed by self-consistent plasma simulations. These simulations require a wide variety of fundamental data as input such as electron-heavy particle collision cross sections, heavy particle reaction rate coefficients and probabilities for the reaction of plasma produced species with surfaces. The methods required, both theoretically and experimentally, to generate the above data are extremely varied and as such the degree to which these data are known for any given plasma system varies significantly from process to process. As a result a major limitation of state-of-the-art plasma simulations is the knowledge of this fundamental collision data. In this work a self-consistent 2D plasma simulation [1] is used to investigate the role of surface interaction probabilities, specifically the thermal energy accommodation coefficient and the atomic oxygen recombination probability, with regard to their influence on the plasma properties in an oxygen inductively coupled plasma (ICP) of the type commonly used in plasma etching applications. It is found that both parameters have a significant effect on the atomic oxygen flux and ion bombardment energy at the substrate holder, two key control parameters for nano-metric precision etching.

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References

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