

Artificial Plasmas: Understanding thin film growth processes

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Abstract

Low temperature plasmas are often used to deposit thin films on various substrates for many applications. In these plasmas a precursor gas is dissociated and ionized and the radicals as well as the ions impinging onto the surface leading to film growth. The final stoichiometry and the material properties depend strongly on the composition, fluxes and energy of the impinging species.

An important material system are carbon based coatings since these films are used as protective layers for tools and optical devices or as first wall material in present day nuclear fusion experiments. Albeit the great importance of this material, detailed knowledge on the elementary mechanism of film formation at the boundary plasma-surface is still very sparse. This is due to the complexity of the growth process where several species like different radicals and ions interact with the film surface simultaneously. One approach to isolate and to quantify individual growth mechanisms is to study selected surface processes in quantified beam experiments. In this talk experiments are presented employing chemical beams of hydrogen atoms, methyl radicals and low energy ions to simulate film growth in a low temperature methane plasma. Such a model system can, therefore, be considered an artificial plasma experiment.

With these experiments it is possible to determine cross sections of various plasma-surface processes as important input parameters for any combined plasma-surface modeling. The understanding of the film formation process allows also to address various open questions ranging from the deposition of hard coatings from expanding thermal plasmas to the mitigation of the tritium retention in the next step nuclear fusion device ITER-FEAT.