OR2305

Numerical Simulation of the Gas Flow in a PECVD Reactor

Sandra Gaiser, Dirk Hegemann

Empa, St. Gallen, Switzerland

sandra.gaiser@empa.ch

PECVD processes are often optimized empirically by adjusting parameters like power, pressure and gas flow rates. This work shows how numerical models can be applied to complement experimental investigations and to obtain a detailed understanding of the processes taking place in a RF plasma device. Besides the complex chemical processes determining the growth and the composition of deposited films, special attention should be paid to the gas flow. Since its properties influence pressure and residence time of the reactive species at the interface between gas volume and surface of the substrate, it is crucial to analyse and adapt the gas flow to improve the deposition process.
The main objective is to adjust the gas management in a way so that uniform gas flow conditions all over the substrate can be realized in order to achieve a homogeneous film growth over a large area. Depending on the considered pressure and the dimension of the geometry, the necessity for an appropriate theoretical description of the gas flow is discussed (continuum flow vs. molecular flow). A numerical model is then presented which describes a laminar continuum gas flow. It is shown how geometrical characteristics of the plasma device and variations of the gas flow rate cause local pressure changes which in turn affect the residence time of the gas on the substrate surface. These parameters are compared with experimentally obtained spatial profiles of the film thickness to set a benchmark for subsequent simulations. The attained information about the influence of the gas flow on the deposition rate is used to further optimize the geometry of the plasma device including the gas management and the positioning of the substrate. To that end, variations of geometrical parameters are carried out in the simulation model in order to identify optimal deposition conditions.

Keywords
numerical simulation
CFD
PECVD
capacitively coupled plasma
modelling