A GLOBAL MODEL COUPLED WITH LANGMUIR ADSORPTION KINETICS APPLIED FOR INVESTIGATION OF INDUCTIVELY COUPLED SF_6 PLASMA ETCHING OF Si AND SiO_2

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Sulfur hexafluoride (SF_6) plasmas are commonly used in the deep etching of silicon (Si), silicon oxide (SiO_2) and more recently silica glass [1]. Due to the complexity of fluorinated plasma environment during Si-based material etching, there are few works presenting experimental and/or theoretical studies about the chemistry established. However, the chemical behavior of the plasma has a direct influence on the etching characteristics such as etch rate, profile and their microscopic uniformity [2]. Thus, it is interesting to understand the dependence of the plasma chemistry with macroscopic process parameters in order to better understand the process tool as well as to optimize it.

In this work, a global model coupled with Langmuir adsorption kinetics has been developed to study the plasma chemistry of reactants and products during SF_6 ICP etching of Si and SiO_2. A complete set of gas phase reactions with respective reaction rates was mounted for SF_6 plasma considering the last database presented in literature. Moreover, through the Langmuir adsorption kinetics model the products of interaction plasma - Si-based substrate surface (for example, SiF_x species, x = 0-4) are calculated and considered as a second gas source in the balance particle formulation of global model. We investigated the dependence of the neutral and charged species density as a function of gas pressure, mass flow rate, discharge power, substrate-holder bias and substrate material (Si or SiO_2). The results indicate that the density of the main product of Si etching, SiF_4, can reach the order of the density of SF_6 specie, confirming the high etch rates observed experimentally for the Si in this type of reactor [3]. Contrary fact is observed for the SiO_2 etching, where the strong link between the Si and oxygen atoms limits the desorption process of Si gas phase species. Some results were compared with experimental results from literature.

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