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Modelling and Study of a Microwave-Plasma-Source for High-rate Etching

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Photoresists are used in industry for lithographic processes to produce surface structures in the sub-micrometer range. In the final step of the manufacturing process, the cured polymer layer acting as shaping die for the microstructures grown by electroplating has to be removed. Etching of the cured resist pattern poses an extreme challenge, as the microstructures must not be damaged. Dry plasma chemical etching by means of radicals generated in the plasma chamber of a remote plasma source (RPS) is a suitable means avoiding damage to the microstructures made of metals like nickel, copper or gold.
The aim of the study is to optimize the existing source with regard to its etching rate and gas temperature and to simplify its setup in order to save production costs. Using the FEM-based simulation software COMSOL Multiphysics a model of the RPS has been developed to investigate the microwave distribution and the microwave coupling into the plasma chamber for different RPS setups. If a plasma is ignited, the electron density and thus the permittivity and the conductivity increase, which changes the electric field distribution in the plasma chamber. For this purpose, the model has been extended in a first step by a collision-free Drude-Lorentz model. By using a high speed camera system during the ignition process the average light intensity can be plotted vs. the time and thus give information about the ignition process itself and the stability of the plasma.
The conclusion gained by the investigation of the RPS through the high speed camera will be presented as well as the FEM-based model of the RPS and results of the measured and simulated E-field distribution in the plasma source. The E-field distribution is experimental measured by heating up substrates and visualized by liquid-crystal sheets, thermal camera and thermal paper. Furthermore, the achieved etching rates and the spatial distribution of the etching rates will be presented.

Keywords
Simulation
Plasma Etching
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