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Multiple frequency capacitive plasmas for PVD: Tuning techniques and influence on ferromagnetic thin films

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Multiple frequency capacitively coupled plasmas (CCP) are a well-known tool for large area etching and plasma enhanced chemical vapour deposition (PECVD) deposition purposes. In contrast, they are still rarely used in physical vapour deposition (PVD) or reactive sputter deposition applications. However, they provide an interesting alternative for thin film deposition of special systems like ferromagnetic materials.
In this work we discuss a dual frequency discharge with excitation frequencies in the VHF and HF band. The influence of various external parameters like applied power ratio and influence of relative phase on plasma properties is studied. Measurements have been performed using a voltage-current-probe for process monitoring, a Langmuir probe for plasma density and electron temperature results, phase resolved optical emission spectroscopy (PROES) for time resolved optical investigations and a plasma series resonance (PSR) current sensor to monitor electron heating. These data are compared to simulation results in order to understand changes in discharge behaviour by adapting external parameters.
Furthermore, deposition experiments using pure iron (Fe) and nickel (Ni) targets have been performed. First, the optimum system pressure for maximum deposition rate was determined using a quartz-crystal microbalance (QCM). Second, a new biasing technique using arbitrary waveforms at the substrate is investigated with respect to its influence on film properties. We intend to tailor the ion distribution function in such a way, that the attracted ions possess a favourable energy distribution on the substrate. First results to this regard are presented comparing thin films of Fe and Ni using different surface diagnostics. Additionally, parallels found in film properties of reactive sputter deposited alumina are shortly outlined.
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