ENERGY AND MOMENTUM FLUXES IN PLASMA PROCESSING

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For an optimization of plasma-based processes as thin film deposition, suitable diagnostics are required. In addition to well-established plasma diagnostic methods (e.g. optical emission spectroscopy, mass spectrometry, Langmuir probes, etc.) we perform examples of “non-conventional” low-cost diagnostics, which are applicable in technological plasma processes. Examples are the determination of energy fluxes by calorimetric probes [1,2] and the measurement of momentum transfer due to sputtered particles or changes of plasma pressure by force probes [3,4].

The total energy influx from the plasma to a substrate can be measured by special calorimetric sensors [1]. One method is the passive thermal probe (PTP) [2] based on the determination of the temporal slope of the substrate surface temperature (heating, cooling) in the course of the plasma process. By knowing the calibrated heat capacity of the sensor, the difference of the time derivatives yields the integral energy influx to the surface. Simultaneously, the electrical current to the substrate can be obtained and by variation of the bias voltage the energetic contribution of charge carriers can be determined. By comparison with model assumptions on the involved plasma-surface mechanisms the different energetic contributions to the total energy influx can be separated.

Furthermore, for thin film deposition by sputtering it is essential to determine the sputtering yield as well as the angular distribution of sputtered atoms. In addition to model calculations (TRIM, TRIDYN etc.), an experimental determination of the related quantities is highly demanded. For this purpose, we developed an interferometric force probe [3]. Such a quite sensitive probe bends a few µm due to momentum transfer by the bombarding and released particles, i.e. sputtered target atoms and recoiled ions [4]. By knowing the material properties of the cantilever and by measuring its deflection, the transferred momentum, e.g. the force in µN range, can be determined experimentally. In the present study, measurements are compared with TRIM simulations for different experimental discharge conditions.

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