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Diagnostic of energy transfers in sputter deposition: a way to investigate the sputtering process and the film growth

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Study of the energy transfer between plasmas and substrate surfaces is of major interest for many plasma processes of material modification, including magnetron sputter deposition. It is well known that the global energy deposited during the growth determines the features of the film, such as its crystalline phase, micro-structure, morphology etc. Estimation of this energy is a quite old issue. This can be done either by energy balances or by measurements performed with specific probes. Calorimetric probes, based on the recording of the temperature evolution, have been widely used. Other kinds of heat flux sensors, exhibiting higher sensitivity and fast response time are now emerging to investigate magnetron sputtering deposition.
Many works dealing with energy transfers have shown that a key parameter to predict thin film features could be the global energy per incoming atom. However recent studies have evidenced that, in some cases, this parameter alone may not be relevant. It has also been shown that other contributions, like IR radiation emitted by the sputtered-heated target has to be taken into account.
Beyond the control of the film properties, energy measurements, coupled to conventional plasma diagnostics, could lead to a better understanding of the mechanisms involved both, in the sputtering process (at the target) and the film growth (at the substrate). For example, chemical reactions at the growing film during reactive sputtering or modification of the sputtering regime of a magnetic target above the Curie temperature have been evidenced by studying energy transfers.

Keywords
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Process control
Elementary mechanisms