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A novel method for the measurement of the momentum of sputtered atoms

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For a variety of thin film applications (e.g. sputtering) it is essential to determine the sputtering yield as well as the angular distribution of sputtered atoms. Therefore, in addition to model calculations (TRIM, TRIDYN etc.) an experimental determination of the related quantities is highly demanded. For this purpose we propose a novel and rather simple method – the so-called sputtering-propelled instrument (SPIN). In principal, the SPIN is a kind of wind wheel where the rotor blades are plane targets of the sputtering material. The wheel, which is stack nearly without friction and exposed to a vertical ion beam, starts to rotate due to momentum transfer by the released particles, i.e. sputtered target atoms and recoiled ions. By knowing the moment of inertia and by measuring the accelerated rotation, the propelling force can be determined experimentally.
For comparison, the sputtering process has also been simulated by TRIM which describes the ion-induced collision cascades on a quantum-mechanic model. For example, for Argon ions of a kinetic energy of 700eV and at an incident angle of 56° on a copper target the major contribution (about 90%) of the propelling force is due to momentum transfer by the sputtered Cu atoms.
In the present study measurements by SPIN and simulation by TRIM are compared for different experimental conditions, e.g. for different ion masses (Ar, Ne, Kr), ion energies (500-1500eV), angles of incidence (10°-80°), target distances (70-500mm) and target materials (Cu, Zn, C).

Keywords
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