Monte-Carlo simulation of ionisation in self-induced ion plating

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Abstract

The present communication deals with the modelling of a new physical vapour deposition process developed in order to produce continuous coating of flat products in the steel industry. This technique, called self-induced ion plating (SIP), is based on the evaporation of a metallic target thanks to a magnetron sputtering system. This combination of PVD processes (evaporation and sputtering) allows to obtain a high deposition velocity and a good deposit adherence.

A numerical simulation model of the SIP process has been already realised in order to predict the thickness profile of the coating. A poster about this model was presented at the Belvac 2003 Symposium. This model was constituted of three coupled submodels: a magnetic model, a heat transfer model and an evaporation model. The simulated results were compared with measurements. The comparison showed that our results did not agree perfectly with the experimental values. This could be explained by the difficulty in doing accurate measurements but also by simplifying assumptions introduced into the model.

The purpose of the present work is to remove one of these assumptions: the use of a non-validated power law to evaluate heat distribution (due to ions bombardment) on target.
To assess if this law is accurate we have programmed a Monte-Carlo simulation of ionisation in the SIP process.

The main steps of the algorithm are :
-The follow-up of the secondary electrons displacement from the target (Lorentz law integration)
-The check (using random number) of the presence of a collision between electron and argon atom
- If a collision occurs, the definition (using random number) of the kind of collision among elastic, excitation and ionisation. For each kind of collision, we have to apply some modifications to the trajectory and the energy of the incident electron

Each time the collision leads to ionisation, we record the coordinates where an argon ion appears. The distribution of ions obtained in this way is an image of the heat distribution due to ions bombardment on the target because ions trajectory is not influenced by the magnetic field. This ions distribution is then compared with the heat flux distribution to determine the adequacy of the law previously used in the model.

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