An investigation of electrical parameters of an industrial plasma ion beam assisted coating environment

Andreas Ohl\textsuperscript{1}, Rüdiger Foest\textsuperscript{1}, Mario Hannemann\textsuperscript{1}, Jens Harhausen\textsuperscript{1}, Hartmut Steffen\textsuperscript{1}, Ruben Wiese\textsuperscript{1}, Klaus-Dieter Weltmann\textsuperscript{1}

\textsuperscript{1}INP-Greifswald e.V., Greifswald, Germany

ohl@inp-greifswald.de

Ion assisted deposition (IAD) gets increasingly attractive for high quality thin film coating, e.g. of optical devices. In a typical arrangement, a broad beam of energetic ions from an inert gas is directed onto a film growing by thermal evaporation. This way, energy deposition is controlled independently of mass deposition. The energy of the beam ions ($\sim 100\text{ eV}$) is chosen such that considerable additional energy deposition to the growing film takes place. Then, the mean energy deposition per deposited film atom can exceed the thermal energy deposition of about $0.1\text{ eV}$ by multiples. As a result, outstanding improvement of film quality is observed provided that other preconditions for high quality are met, too. A very stringent requirement is working pressure below $10^{-2}\text{ Pa}$. Also, reasonable growth rates $0.1\text{ nm/s}$ at a sufficiently large substrate area of $\sim 1\text{ m}^2$ are indispensible for efficiency reasons. But generation of high ion fluxes at very low pressure is challenging. Grid-less, open ion beam sources can inject intense plasma ion beams into high vacuum deposition vessels. They are sophisticated devices which combine magnetic field confinement with further technical means to obtain the desired plasma beam parameters. Accordingly, control of these sources is complex and requires further improvement. Here we report respective measurements of electrical control parameters of a gridless APSpro plasma ion beam source. This source is successfully used in industrial environments. It functions on the basis of a combination of hot cathode discharge and coaxial magnetron discharge. Accordingly, observed discharge current-voltage characteristics are substantially deviating from typical magnetron discharge characteristics. Determination of cathode temperature showed, that two discharge regimes exist which differ by the prevailing cathode heating mechanisms. The correlation of plasma ion beam parameters with current-voltage characteristics was studied by electrostatic probes and thermal probes. Besides high-energetic ions the beam is also characterized by high-energetic electrons.

Keywords
ion assisted deposition
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current-voltage characteristics