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A REACTIVE SPUTTERING MODEL FROM DCMS TO HIPIMS

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In the last decade, high power impulse magnetron sputtering (HiPIMS) acquired much attention from the sputtering community as a new successfully sputtering technology. The technique is already well-established in several industrial applications. In HiPIMS, a high power load is directed towards the target at a low duty cycle and frequency such that the average power is comparable with classical direct current magnetron sputtering (DCMS). However, during the high current pulse the fraction of sputtered atoms that become ionized is greatly enhanced due to the high plasma density. Also gas rarefaction effects in front of the target will play a more significant role compared to typical DCMS conditions. These features will have their influence on the process curve during reactive HiPIMS. It is reported that reactive HiPIMS suffers less from hysteresis effects compared to DCMS. This diminishing hysteresis effect has been linked with several causes: sputter cleaning due to the high ion current, high doses of metal implantation or low surface reactivity due to reactive gas rarefaction. These causes have been investigated by means of modelling. An extension on the RSD2013 model [J. Phys. D Appl. Phys. 47, 235302 (2014)] which originally aimed the description of the hysteresis for DCMS, has been developed for HiPIMS. This RSD HiPIMS model is capable to unravel the hysteresis behavior for the HiPIMS deposition technology in combination with the Monte-Carlo codes SiMTra, for the transport of the sputtered species, and SRIM, for the ion-target interactions. In the model the change of the target condition from the metallic to the poisoned state is performed by including mainly three target processes: the chemisorption of reactive gas species, reaction of direct and knock-on implanted reactive species and the redeposition/reimplantation of sputtered material. Both the state of the target and the substrates are hereby described in a spatial and temporal resolved way. Notwithstanding the more complex picture of reactive HiPIMS, most mechanisms connected with the reactive aspect of the process show strong resemblance with classical reactive DCMS.

Keywords
HiPIMS
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