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MASS-RESOLVED SPECTROMETRY OF ION FLUX FROM HOT-TARGET REACTIVE HIPIMS DISCHARGE WITH CU, CR, AND SI TARGETS*

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High-power pulsed magnetrons enable obtaining denser and stronger coatings as compared to conventional low-ionization DC magnetrons. The use of pulsed magnetron discharges in reactive modes is a promising method for obtaining optical and structural coatings of complex composition. As a rule, working with reactive gases significantly reduces the target sputtering rate and, as a consequence, the rate of coating deposition. The use of a magnetron with a hot target could overcome this drawback, but the specifics of reactive HiPIMS discharges operated with hot targets have not been studied well. Among the most valuable characteristics are the parameters of the ion fluxes ejected from discharge region that eventually arrive at the substrate surface and contribute to the coating growth.

Our work is devoted to the study of the composition of ion fluxes from hot-target reactive HiPIMS discharge. Experiments were carried out for thermally insulated Cu, Cr, and Si targets. These materials are known for their comparatively high vapor pressure and the possibility of sustaining magnetron discharge exclusively in target vapors [1]. The HiPIMS discharge was operated in O_2/Ar mixtures for Cu and Si targets, and in N_2/Ar mixture for Cr target. For these target/gas pairs, the component composition of ion fluxes from plasma was measured by a custom magnetic mass-analyzer as a function of the reactive gas flow. An example of mass spectrum is shown in Fig. 1.

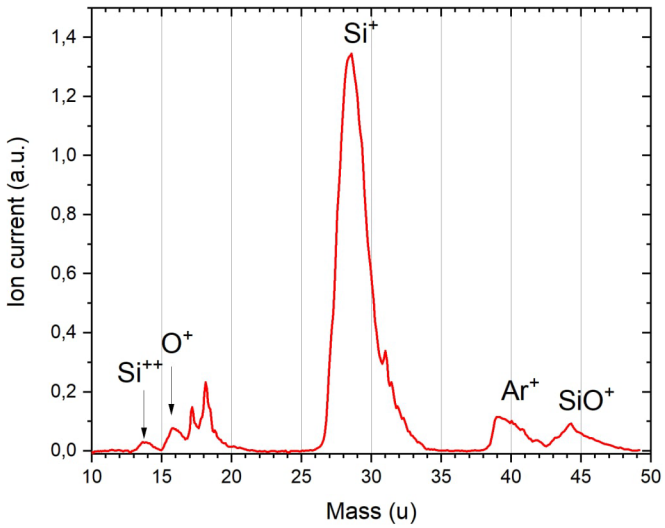

Fig.1. Mass spectrum of ion flux from HiPIMS discharge on Si target in O_2/Ar.

In the experiments, sharp changes in the ratio of fluxes of different ions were observed once the injected reactive gas flow exceeded certain levels. Nevertheless, in the HiPIMS mode, the dominant fraction of the ions are those of the target material.

Specifically, for Si/O_2 case, it is worth noting that the evaporation rate of the oxide is significantly higher than that of pure silicon. This significantly increases the rate of Si_xO_y coating deposition, which is therefore grown not only by the oxidation of the deposited silicon, but also by the deposition of the evaporated oxide. This is observed in the mass spectra of the ion flux where SiO^+ ions are clearly present.

REFERENCES

[1] A.V. Kaziev, K.A. Leonova, M.M. Kharkov et al., "Current–voltage characteristics of an impulse magnetron discharge in target material vapor," J. Phys.: Conf. Ser., Vol. 1686, Article Number 012019, 2020.

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