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The role of pre-ionization in high power impulse magnetron sputtering discharges

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The conventional sputtering techniques, such as DC magnetron, have been modified over the years in order to obtain higher ionization degrees of sputtered metal. One of the improvements consists in the use of high power pulses [1], generating higher plasma densities and higher ionization degrees. The use of pre-ionization stages has been proved to reduce the ignition time, giving the possibility to use shorter pulses [2]. In this work we have used a home made pulsed power supply comprising the following modules: resonant capacitor charger, high power pulser, driving generator, pre-ionizer bias supply and arc handling module. The frequency and pulse width are linearly adjustable in the ranges 1 Hz–100 Hz and 50 µs–150 µs respectively. The pre-ionizer bias module is a 5 mA–100 mA constant current power supply and 1000 V in open circuit. The magnetron discharge, with a 2 inch copper target, was operated with and without DC pre-ionization, in order to study the effect of the pre-ionization on the functioning of the discharge. The electrical parameters were monitored to show the transition from low current DC like regime to the high current regime, and its dependence on applied voltage, gas pressure and pre-ionization current. The high current regime is characterized by the presence of strong metal ion emission lines, which overcome the metal and argon gas time averaged emission lines. The time resolved emission intensity of both metal and gas lines (ions and neutrals) is shown and discussed in relation with the current voltage characteristic and the stages of the pulsed discharge. Comparison of thin films structure and properties is shown, for thin films deposited in similar power conditions with and without DC pre-ionization.

References

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