Discharge and plasma characteristics of pulse enhanced vacuum arc evaporation (PEVAE) for titanium cathode

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Abstract. This paper reports experimental investigation of the discharge behavior of pulse-enhanced vacuum arc evaporation (PEVAE) with titanium target. The PEVAE discharge was analyzed by optical emission spectroscopy, monitoring of substrate current and the electron probe current at different N2 pressure or arc current, respectively, compared to that of conventional dc arc. The results show that during the PEVAE process the electron probe current was significantly enhanced particularly at a higher pulsed current. An increase of up to more than 1-2 times was observed. Electron emission was substantially enhanced. The substrate current increased linearly with arc current regardless of the dc or PEVAE mode; however, the latter led to a larger current-rise slope. The substrate current with the PEVAE mode was improved to over 7 times. The optical emission spectra of plasma at nitrogen atmosphere showed that the intensities of ion species (e.g., Ti^{2+}, Ti^{+}, N^{+}, $N2^{+}$) gradually increased with pulsed arc current for the PEVAE mode. Electron temperature derived from Ti^{+} ion spectra was 0.55-0.6 eV and changed slightly in the PEVAE mode or dc mode. The increase in plasma spectral intensity is caused by the plasma density increase from larger ion density. These results imply that PEVAE may be an effective technique for film deposition of better microstructure and properties due to higher substrate current induced by larger electron emission and plasma density.

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