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Time-resolved optical emission spectroscopy of a unipolar and a bipolar pulsed magnetron sputtering discharge operated in an argon/oxygen gas mixture

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Reactive high power impulse magnetron sputtering (HiPIMS) of a cobalt cathode in pure argon gas at a gas pressure of 1 Pa and with different oxygen admixtures was investigated by time-resolved optical emission spectroscopy and time-integrated energy-resolved mass spectrometry. The HiPIMS discharge was operated at a repetition frequency f = 100 Hz with a duty cycle of 1 %. A bipolar pulsed power supply capable of providing a large negative voltage (up to -1000 V) with a typical pulse width of 100 µs followed by a long positive pulse (+60 V) with a pulse width of about 350 µs was employed. The HiPIMS plasma in pure argon is dominated by Co^+ ions. With the addition of oxygen, O^+ ions become a prominent positive ion species. Optical emission spectroscopy reveals the presence of Ar I, Co I, O I, and Ar II emission lines. The transition from an Ar-burning to a Co-burning discharge is inferred from time-resolved OES. The enhanced intensity of excited Ar^{+}* is explained by simultaneous excitation and ionization induced by energetic secondary electrons from the cathode. The intensity of violet Ar I lines is drastically reduced during HiPIMS. The intensity of near-infrared Ar I lines resumes during the positive pulse indicating an additional heating mechanism.

Keywords
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