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Study of the ionisation in a nickel plasma by Inductively Coupled Impulse Sputtering (ICIS)

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Inductively coupled impulse sputtering (ICIS) removes the need for a magnetron, while delivering equal or higher ion to neutral ratios compared to HIPIMS. This is especially advantageous for the sputtering of magnetic materials, as these would shunt the magnetic field of the magnetron, thus reducing the efficiency of the ionisation process. ICIS produces highly ionised metal plasmas inside a high power pulsed RF coil with a magnet free high voltage pulsed DC powered cathode.In this new technology the ionisation degree of magnetic materials and corresponding coating properties are not known.
The setup comprises of a 13.56MHz pulsed RF coil operating at a frequency of 500Hz and a pulse width of 150µs. A pulsed DC voltage of 1900V was applied to the cathode to attract Ar ions and initiate sputtering. OES spectra for Ar, Ti and Ni species sputtered at a constant pressure of 1.2×10^{-1}mbar show a linear intensity increase for peak RF powers of 1000-4200W.The influence of pressure on the process was studied at a constant peak RF power of 3000W for pressures of 3.2×10^{-2}- 2.6×10^{-1}mbar.The intensity of Ni neutrals rises linearly and saturates for pressures above 1.2×10^{-1}mbar.Ar neutrals rise linearly with increasing pressure.Emission modelling is conducted for the Ni process.
The deposition rate for Ni is 50nmh^{-1} for a RF-power of 3000W and a pressure of 1.4×10^{-1}mbar.The microstructure of the coatings shows globular growth.Bottom coverage of unbiased vias with a width of 300nm and aspect ratio of 3.3:1 was 15% and for an aspect ratio of 1.5:1 was 47.5%. The ionisation degree was increased via two different routes - RF power and pressure.The effects on coating microstructure and bottom coverage are discussed.
The current work has shown that the concept of combining a RF powered coil with a magnet-free pulsed DC-powered cathode works very well for the sputtering of hard magnetic material in very stable plasma.

Keywords
ICIS
Magnet-free sputtering
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Magnetic material