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Influence of nitrogen content on NixN thin films deposited by reactive magnetron sputtering.

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The Ni-N system can crystallized in many phases. Two Ni_xN_y phases are stable, Ni_4N which crystallizes in cubic phase and Ni_3N which crystallizes hexagonal phase. Some recent study highlighted a third structure corresponding to Ni_2N. Other phases such as Ni_3N_2 et NiN_6 have been synthesized by chemical processes but never by reactive magnetron sputtering. Most studies, related to NiN by reactive sputtering, report a mixture of nitrided phases. Ni_4N reveals ferromagnetic behavior while Ni_3N and Ni_2N are paramagnetic. This material can also be used as negative electrode for Li battery and solar cells. Furthermore, Ni_xN can also be used as resistive switch.
This study deals with optimization of DC reactive magnetron deposition process using a pure nickel target (99.995%) in an Ar-N2 gas mixture with varied nitrogen gas flow and bias voltage (floating or -100V).
The characterization of the NiN films has been carried out by X-ray diffraction (XRD), X-ray photoelectrons spectroscopy (XPS), Energy dispersive X-ray Spectroscopy (EDXS), SEM and AFM.
XRD measurements have highlighted the deformation of the Ni cubic cell as a function of nitrogen content and a mixture of nitrided phases (Ni_4N, Ni_3N and Ni_2N) appears for 20% N_2 in the discharge.
XPS and EDX are well correlated. The XPS peaks of N1s situated at 396,2 eV and 397,6 eV are attributed to Ni-N-O and N-Ni bonds and permit us to determine three zones : metallic between 0 and 20% N_2, Ni_4N between 20% and 42% N_2 and finally Ni_3N for higher than 42% N_2. These three zones are in good agreement not only with deposition rate and optical emission spectroscopy measurements but also with roughness, electrical resistivity and hardness.

Keywords
Nickel Nitride
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XPS analysis
XRD