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Sputter-deposited chromium oxynitride films for strain sensing at high temperature

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Strain and pressure sensing for the high temperature range are increasingly in demand, e.g. for use in chemical reactors and gas turbines. Different thin film materials that are stable in high temperature are subjects of research. Some have an enhanced strain sensitivity, making them particularly promising.
In this work, the properties of highly sensitive chromium oxynitride films are presented. Films are deposited on heated glass substrates by DC sputtering from a chromium target in argon atmosphere with small amounts of reactive gas (air or nitrogen). Samples are patterned using a picosecond laser.
Annealing in air above the desired application temperature leads to relatively small changes of film properties and makes films stable at high temperature. Films are characterized up to 350 °C with measurements of gauge factor and resistivity drift in vacuum and in air.
Films resistivity is about 10 times larger than in bulk chromium. Gauge factors are in the range of 15, i.e., about 5 times larger than those of typical metal films. Unlike metallic films, they are highly sensitive to transverse as well as longitudinal strain.
The temperature coefficient of resistance is adjustable (0±500 ppm/K) by varying deposition parameters and annealing, but the resistivity over temperature shows anomalous changes in slope.
Grazing incidence X-ray diffraction and transmission electron microscopy reveal a nanocrystalline chromium thin film. Using X-ray photoelectron spectroscopy it is found that the films have a composition of chromium, oxygen and nitrogen with up to 10 at-% oxygen and up to 5 at-% nitrogen. They can thus be considered chromium oxynitride, $Cr_{1-x-y}O_xN_y$. It is possible that charge transport takes place by electron tunnelling across insulating barriers of oxide and nitride in between chromium crystallites, leading to high resistivity and strain sensitivity.

Keywords
chromium
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