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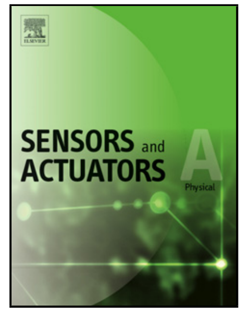

Title: Influence of the Sputter Gas Composition on the Electromechanical Properties and on the Stability of $TiAlN_xO_{1-x}$ Thin Films

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Influence of the Sputter Gas Composition on the Electromechanical Properties and on the Stability of $TiAlN_xO_{1-x}$ Thin Films

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Highlights

- The influence of sputter gas composition on the electromechanical properties of $TiAlN_xO_{1-x}$ thin films has been estimated up to 500°C
- The temperature coefficient of resistance for the layers has been measured up to 500°C
- The oxide layer growth rates have been studied
- The composition of the oxide layer and oxidation process itself have been analysed

Abstract

Sputter deposited $TiAlN_xO_{1-x}$ thin films are investigated as potential candidates for high temperature strain gauge applications. In this study the influence of the reactive gas atmosphere during deposition on the electromechanical properties is investigated up to 500°C with a custom-built measurement setup enabling gauge factor determination. It is shown, that $TiAlN_xO_{1-x}$ thin films with no oxygen admixture during the deposition process show the most promising electromechanical properties. The gauge factor decreases from 3.3 to 2.4 between room temperature and 500°C, while in this temperature range the linear temperature coefficient of the electrical resistance has a value of $-3.8\cdot10^{-4}$ K^{-1}. Time-of-flight secondary mass ion spectrometry measurements are evaluated against the results of electrical resistance measurements to estimate the growth of an oxide layer on the surface of the $TiAlN_xO_{1-x}$ thin films when operated at 500°C in air.

Keywords: TiAlNO; gauge factor; oxidation; strain gauge;

1. Introduction

Despite the achievements realized in the last decades, there is still a strong push for further miniaturization by a simultaneous increase in the functionality and reliability of micromachined sensor elements for e.g. consumer, automotive or industrial applications. Especially when targeting the latter two fields the sensor elements often need to withstand harsh environmental conditions as they are operated at enhanced temperatures ranging up to even 1200°C in chemically aggressive media such as fuels and lubricants [1]. Basically, sensor elements based on the piezoelectric transducer principle are a good choice given these requirements [2]. Their great drawback is, however, the inability to measure precisely true static pressure levels for most of the industrial applications. In contrast, strain gauge sensors are able to detect both static and dynamic pressure loads. As standard metallic strain gauges are applied to polymer foils and fixed on the structure of interest by gluing the applicability to measure under harsh environmental conditions such as combustion processes is strongly limited especially due to a low temperature stability of the organic material. There are strain gauges commercially available, which are embedded in high temperature stable, electrically insulating material sealing the sensitive elements hermetically. They are weldable to the structure of interest, but the complicated set-up results in device geometries of around 10 mm [3], thus lacking so far a further miniaturization.