

ABSTRACT

The doctoral dissertation focuses on studying and analyzing selected properties of thin films composed of titanium and cobalt oxide mixtures (Ti,Co)O_x with varying material compositions, produced using the magnetron sputtering method. It also aims to identify potential application areas for these materials in electronics as functional coatings. This is due to the properties and numerous advantages of titanium and cobalt oxides. Titanium dioxide is widely used in the production of optical coatings, as a gas-sensitive layer in sensor technology, and as a photocatalyst. Meanwhile, cobalt and its oxides are employed as magnetic semiconductor materials and are utilized in the construction of magnetic memory devices. As a result, materials based on these oxides have significant potential for practical applications in electronics. However, the properties of their mixtures have not been sufficiently studied so far. Consequently, a thorough evaluation of their characteristics and application potential remains a challenge.

For the purposes of this study, two series of (Ti,Co)O_x thin-film coatings were prepared using the magnetron sputtering method at the Thin-Film Technologies Group within the Department of Electronic and Photonic Metrology at Wrocław University of Science and Technology. The coatings were deposited using both a continuous flow process and a gas impulse magnetron sputtering (GIMS) method. To assess the impact of material composition, thin films containing between 2 at.% and 60 at.% cobalt were produced. Their characterization was performed using various techniques, including scanning electron microscopy (SEM), atomic force microscopy (AFM), X-ray diffraction (XRD), optical profilometry, optical spectroscopy, and current-voltage measurements.

A comprehensive analysis of the properties of (Ti,Co)O_x thin films prepared in the continuous gas flow process revealed that they exhibit high transparency, and some of them demonstrate photocatalytic activity or exhibit a memristive effect. This suggests that these transparent films could be used as self-cleaning coatings or in the development of memory-effect structures. On the other hand, the analysis of films prepared using the GIMS process indicated that they possessed semiconductor properties. By selecting an appropriate cobalt content, a relatively high level of light transmission was maintained, and a significant sensor response to hydrogen was achieved without the need for an additional catalytic film. This suggests the potential application of selected (Ti,Co)O_x thin films in sensor technology.

Patrycja Polow