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Nanocomposite Materials for Microchannel Plate Detectors

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Precisely controlled metal-metal oxide nanocomposite layers prepared by atomic layer deposition (ALD) exhibit material properties that can be tuned over a broad range by adjusting the metal content such as band gap, absorption coefficient, resistivity, and electrochemical corrosion resistance. Consequently, these metal-metal oxide nanocomposites are well suited especially as a resistive layers for microchannel plates (MCPs) functionalization.

For resistive layers in MCPs, both resistance stability with respect to applied potential and the thermal coefficient of resistance (TCR) are the critical materials property because it dictates the range of allowable operating voltage and temperatures for devices (e.g. photon, neutron, or particle detectors) that incorporate the MCP for electron amplification. The ability to control the TCR will enable new applications such as cryogenic detectors or detectors that must endure large temperature changes during operation. To address this need, we have synthesized a variety of ALD metal-metal oxide nanocomposite layers by combining different metals (W, Mo, Ta, Nb, and Re) and metal oxides (Al2O3, ZrO2, TiO2, Ta2O5, Nb2O5, and HfO2). We studied the electrical transport properties of these ALD films and focused on their temperature dependence in order to extract the TCR. In all cases, the TCR is negative, so that the resistance drops with increasing temperature as expected for a semiconducting material. In addition, the magnitude of the TCR increases with the film resistivity, and depends on both the metal and the metal oxide components of the composite. This presentation will expound on these findings and explain the implications for MCP detectors.

Primary author: Dr MANE, Anil (Argonne National Lab)

Co-authors: ELAM, Jeff (Argonne National Laboratory); POPECKI, Mark (Incom Inc); GEBHARD, Maximilian (mgebhard@anl.gov); Dr MINOT, Michael (Incom, Inc.); CREMER, Till (Incom Inc)

Presenter: Dr MANE, Anil (Argonne National Lab)

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