Study of the effect of thin ALD oxide coatings on the stability of silver nanowire based transparent electrodes

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Current research on new Transparent Conductive Materials focuses on emerging materials such as carbon-based materials, graphene or metallic nanowire networks. The latter concern mainly silver nanowires (AgNW). Although AgNW networks seem to approach ITO values in terms of optical transparency and electrical sheet resistance, (90% and 10 Ω/sq respectively) [1], overcoming a rather poor thermal and electrical stability still remains a challenge. While most device fabrication processes require thermal annealing steps to optimize their electrical properties, heating can modify AgNW network morphology. Moreover, when used as transparent heaters, an electrical current induces specimen heating (due to Joule effect) and then imposing AgNW network to be resistant to heat.

One way to improve thermal stability of AgNW networks is to use a thin layer of a passivating metal oxide (such as ZnO or TiO_2) which induces stability improvements [2]. So far, our group has studied the effect of a thin layer of TiO_2 deposited by ALD on the thermal and electrical stability of AgNWs networks. Our studies show that even a TiO_2 layer as thin as 5 nm can lead to an extension of thermal stability from 270 °C to 420 °C. The oxide coating also increases the value of the electrical failure voltage. This stability enhancement comes with nearly no change in optical transparency (less than 1%). Currently we are replacing the ALD deposition method with a new approach called Spatial ALD (SALD). This technique does not require vacuum, it is much faster than conventional ALD and is easily scalable [3]. Here we will present a comprehensive study of the effect of deposition parameters, passivation film thickness on the electrical and optical properties of AgNWs based transparent electrodes. Optimized parameters will allow the integration in devices such as transparent heaters. We will demonstrate that adding a passivation layer increases the breakdown voltage, making the devices stable at higher voltage or temperature.

References:

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