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Optimization of SOL-Gel Copper Oxide Layers for Field-Effect Transistors

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Abstract : In recent years, alternative materials are gaining attention to replace polycrystalline and amorphous silicon, which are a standard for low requirement devices, where silicon is unnecessarily and high cost. For that reason, metal oxides are envisioned as the new materials for these low-requirement applications such as sensors, solar cells, energy storage devices, or field-effect transistors. Their most common way of layer growth is sputtering; however, this is a high-cost fabrication method, and a more industry-suitable alternative is the sol-gel method. In this group of materials, many oxides exhibit a semiconductor-like behavior with sufficiently high mobility to be applied as transistors. The sol-gel method is a cost-effective deposition technique for semiconductor-based devices. Copper oxides, as p-type semiconductors with free charge mobility up to 1 cm2/Vs., are suitable replacements for poly-Si or a-Si:H devices. However, to reach the potential of silicon devices, a fine-tuning of material properties is needed. Here we focus on the optimization of the electrical parameters of copper oxide-based field-effect transistors by modification of precursor solvent (usually 2-methoxy ethanol). However, to achieve solubility and high-quality films, a better solvent is required. Since almost no solvents have both high dielectric constant and high boiling point, an alternative approach was proposed with blend solvents. By mixing isopropyl alcohol (IPA) and 2-methoxy ethanol (2ME) the precursor reached better solubility. The quality of the layers fabricated using mixed solutions was evaluated in accordance with the surface morphology and electrical properties. The IPA:2ME solution mixture reached optimum results for the weight ratio of 1:3. The cupric oxide layers for optimal mixture had the highest crystallinity and highest effective charge mobility.

Keywords : copper oxide, field-effect transistor, semiconductor, sol-gel method
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