High Performance P-type Tin Monoxide Thin Film Transistor for Back-end of Line Applications

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Abstract

Recently, amorphous oxide semiconductors (AOS) have received much attentions for a wide range of emerging applications such as monolithic 3D-ICs. Compared with conventional amorphous silicon, AOS materials shows multiple advantages including high electron mobilities, low fabrication temperatures, highly uniform surfaces. So far, most AOS materials are n-type such as amorphous Indium-Zinc-Gallium-Oxide (a-IGZO). In contrast, there are relatively few studies on p-type oxide semiconductors. Among various p-type materials, tin monoxide (SnO) is considered a promising p-type semiconductor owing to its effective hole carrier creation resulting from the low formation energy of Sn vacancies. In addition, a much more delocalized state formed by the hybridization of the Sn 5s and O 2p orbitals leads to a relatively low hole effective mass, resulting in good hole-transport properties. On the other hand, there are two oxidation states of tin: Sn^{2+} (stannous oxide SnO) and Sn^{4+} (stannic oxide SnO_2). SnO film is usually at an unstable phase, easily decomposed to SnO_2 at above 270±±20°C. Furthermore, SnO_2 is n-type semiconductor, showing a much more stable oxide state of tin.

In this work, by adjusting different process parameters for p-type SnO thin film synthesis, the p-type SnO TFTs exhibits a high mobility of ~2 $cm^2/V{\cdot}s$ and on−off current ratio of nearly 10^4. The high-performance p-type TFT is developed. To sum up, SnO TFT with great electrical characteristics shows high potential for back-end of line (BEOL) applications.

Keywords - P-type Oxide, Tin monoxide (SnO), Back-end of line (BEOL)