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Rare-metal-free high-performance Ga-Sn-O thin film transistor

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Oxide semiconductors have been investigated as channel layers for thin film transistors (TFTs) which enable next-generation devices such as high-resolution liquid crystal displays (LCDs), organic light emitting diode (OLED) displays, flexible electronics, and innovative devices. Here, high-performance and stable Ga-Sn-O (GTO) TFTs were demonstrated for the first time without the use of rare metals such as In. Substituting Sn for In is a reasonable countermeasure for avoiding the use of rare earth metals. Moreover, In and Sn have similar electronic structures and electrical properties. The GTO TFT was fabricated on a Si wafer with thermal oxide. The GTO thin films were deposited using radiofrequency (RF) magnetron sputtering. A high field effect mobility of 29.9 cm^2/Vs was achieved as shown in Figure 1. The stability of the GTO TFTs was examined under bias, temperature, and light illumination conditions. The electrical behavior of the GTO TFTs was more stable than that of In-Ga-Zn-O (IGZO) TFTs, which was attributed to the elimination of weak Zn-O bonds. High field effect mobility TFT with a low S factor was prepared using GTO, where the rare earth In was replaced by Sn. The stability of the GTO TFT without a passivation film under various accelerated operating conditions was significantly higher than that of equivalent IGZO TFTs. Although we compared the IGZO and GTO TFTs fabricated in our laboratory just for evaluation of the materials themselves, because TFT characteristics are influenced by the treatment of backchannel such as passivation materials and methods, and surface treatment the effective treatments for IGZO TFT can also be effective for GTO TFT. We propose such GTO TFTs as key devices suitable for use in next-generation technologies such as displays, power devices, and artificial intelligence devices such as neural networks.

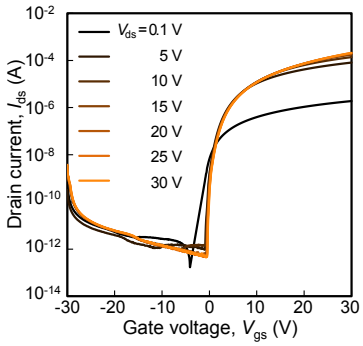

Figure 1: Transfer characteristics (I_{ds}-V_{gs}) of GTO TFT.

Biography

Tokiyoshi Matsuda has his expertise in fabricating amorphous oxide semiconductor materials, evaluation of defects in the oxide semiconductor, and its TFT application. He proposed the model of oxygen vacancy in IGZO. These oxide semiconductors are suitable for use in novel devices not only next-generation displays, but also power devices and artificial intelligence devices such as neural networks.

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