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Negative Bias Illumination Stress (NBIS) Stability Analysis of MoS_2 Thin-Film Transistor (TFT)

The transition metal dichalcogenides (TMDCs) have high transparency, flexibility, and good electrical property. For these reasons, they are promising as a channel material of a Thin film transistor (TFT). Among various kinds of TMDCs, molybdenum disulfide (MoS_2) is well known as a two-dimensional n-type semiconductor material. The MoS_2 has been studied for TFT in recent years because it has a relatively high on-off current ratio, high mobility and excellent flexibility [1]. In the case of the TFTs based on oxide semiconductor, there have been previous studies on the stability of TFTs under gate bias stress and light [2,3]. However, there is still an insufficient number of stability studies for MoS_2. The negative bias illumination stress (NBIS) stability is a parameter that indicates the stability of TFTs when voltage and light are applied to the TFTs at the same time. In general, NBIS stability is expressed as a shift in threshold voltage (V_{th}). The NBIS-induced V_{th} shift is highly related to the charge trap at the interface between the channel and the dielectric [4]. In this study, we investigated the electrical stability of MoS_2 TFT under NBIS on aluminum oxide dielectric (Al_2O_3) and hybrid dielectric (Al_2O_3/pV3D3). The stability under NBIS can be investigated by the V_{th} shift of each gate insulators. To quantify this, the time-dependent V_{th} shift was fitted to a stretched-exponential equation [5]. It was found that the V_{th} shift decreases on the hybrid dielectric (Al_2O_3/pV3D3). The pV3D3 dielectric layer based on the iCVD process was inserted between the Al_2O_3 dielectric and the MoS_2 channel. The pV3D3 layer protects the functional group such as the hydroxyl (–OH) acting as trap sites at the interface between MoS_2 and the Al_2O_3 dielectric [6]. As a result, The hybrid dielectric (Al_2O_3/pV3D3) reduces the interfacial trap density at the interface and suppresses interfacial charge trapping. This study reveals the effect of dielectric on the electrical stability of MoS_2 TFT under NBIS, and the hybrid dielectric (Al_2O_3/pV3D3) improved electrical stability under NBIS.

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