ミスト CVD 法による $Al_{1-x}Ti_xO_y$ 薄膜の作製とゲート絶縁膜への応用

$Al_{1-x}Ti_xO_y$ Thin Films Synthesized by Mist-CVD and Applied as a Gate Insulating Layer

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We investigated the synthesis of aluminum oxide (AlO_x) thin films using mist chemical vapor deposition (mist-CVD) from aluminum acetylacetonate ($Al(acac)_3$) and CH_3OH/H_2O mixture. Different deposition parameters, such as the flow rate of dilution gas N_2 (F_d), furnace temperature (T_f), solution concentration, and mesh bias (V_m) were optimized via the analysis of the size distribution of mist precursors using a fast-scanning mobility particle analyzer. The film morphology, the rigidity of the AlO_x network, and junction property at the AlO_x/n-type crystalline Si (n-Si) were dominated by the size distribution of the mist precursors. Further, the V_m supply during film growth promoted the miniaturization of the size distribution of the charged mist particles, resulting in an increased refractive index (n) of the AlO_x thin films with small surface roughness values. Furthermore, such property of the AlO_x films improved the junction property at the AlO_x/n-Si interface [1]. In the present study, the effect of titanium precursor $Ti(acac)_4$ additive on the growth of $Al_{1-x}Ti_xO_y$ thin films were investigated for different $Ti(acac)_4/Al(acac)_3$ ratios. Understanding the junction property at the $Al_{1-x}Ti_xO_y$/n-Si interface and examining the potential of $Al_{1-x}Ti_xO_y$ obtained through by mist-CVD to act as a gate insulator layer for MOS-FETs are also investigated compared with solely AlO_x by using mechanically exfoliated $MoSe_2$ flake as a channel. Figure 1 shows the bandgap energy E_g and n value at 3.5 eV for $Al_{1-x}Ti_xO_y$ films with different x values. E_g decreased gradually from 6.35 to 3.6 eV together with the increase of n value when x value was increased. Figure 2 shows the V_g-I_{sd} characteristics for the $MoSe_2$ FETs (thickness of 30-40 nm) on a ~40 nm thick $Al_{1-x}Ti_xO_y/p^+$-Si with different x ratios. The FET mobility increased markedly together with lowering V_{th} by adjusting the x value. These findings suggest that mist-CVD $Al_{1-x}Ti_xO_y$ films have great potential as a gate insulating layer. [1] A. Rajib, et. al., *ACS Applied Electronic Mater*. (2021).

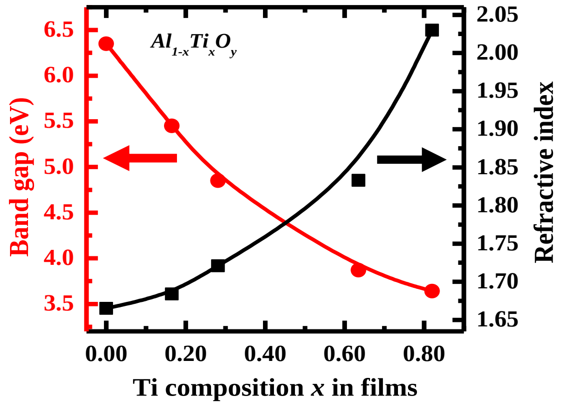

Figure 1: E_g and n value at 3.5 eV of $Al_{1-x}Ti_xO_y$ thin films as a function of x value.

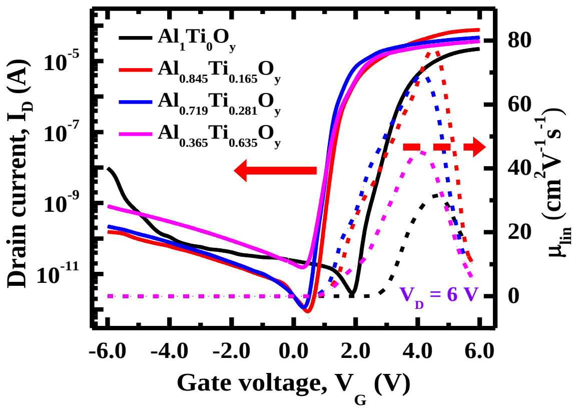

Figure 2: V_g-I_D characteristics of the $MoSe_2$ based FETs with $Al_{1-x}Ti_xO_y$ as a gate insulator layer for different x values.