

비정질 산화물 반도체의 열전특성  
Transparent Amorphous Oxide Semiconductor as Excellent Thermoelectric Materials

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**초 록:** Only approximately 30% of fossil fuel energy is used; therefore, it is desirable to utilize the huge amounts of waste energy. Thermoelectric (TE) materials that convert heat into electrical power are a promising energy technology. The TE materials can be formed either as thin films or as bulk semiconductors. Generally, thin-film TE materials have low energy conversion rates due to their thinness compared to that in bulk. However, an advantage of a thin-film TE material is that the efficiency can be smartly engineered by controlling the nanostructure and composition. Especially nanostructured TE thin films are useful for mitigating heating problems in highly integrated microelectronic devices by accurately controlling the temperature. Hence, there is a rising interest in thin-film TE devices. These devices have been extensively investigated.

It is demonstrated that transparent amorphous oxide semiconductors (TAOS) can be excellent thermoelectric (TE) materials, since their thermal conductivity ( $\kappa$ ) through a randomly disordered structure is quite low, while their electrical conductivity and carrier mobility ( $\mu$ ) are high, compared to crystalline semiconductors through the first-principles calculations and the various measurements for the amorphous In-Zn-O (a-IZO) thin film. The calculated phonon dispersion in a-IZO shows non-linear phonon instability, which can prevent the transport of phonon. The a-IZO was measured to have poor  $\kappa$  and high electrical conductivity compared to crystalline  $\text{In}_2\text{O}_3:\text{Sn}$  (c-ITO). These properties show that the TAOS can be an excellent thin-film transparent TE material. It is suggested that the TAOS can be employed to mitigate the heating problem in the transparent display devices.