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MBE deposited scandium nitride (ScN) for thermoelectric applications

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Scandium nitride (ScN) is an emerging rocksalt III-nitride semiconductor and has attracted significant interests in recent years for its potential thermoelectric applications, as a substrate for high-quality epitaxial GaN growth and as a semiconducting component for epitaxial single-crystalline metal/semiconductor superlattices for thermionic energy conversion. In this poster, we show high mobility and high thermoelectric power factor in epitaxial ScN thin films deposited on MgO substrates with plasma-assisted molecular beam epitaxy (PAMBE). Structural and microscopic characterization showed epitaxial 002 oriented ScN film growth on MgO (001) substrates and the presence of extended defects including dislocations and grain boundaries. Electrical measurement exhibited high room-temperature mobility of 127 cm^2/Vs and temperature-dependent mobility from 50-400 K temperature range that is dominated by dislocation and grain boundary scattering. Due to the high mobility and a moderately large carrier concentration (8.6×10^{19} cm^{-3}), ScN films exhibit high Seebeck coefficients (180 μV/K at 950 K) and a large thermoelectric power factor (2.3×10^{-3} W/m K^2 at 500K). The thermal conductivity measured with a time-domain thermoreflectance (TDTR) measurement system exhibit a value of 7.33 W/m K at 500 K that results in a maximum *ZT* of 0.2. Further research on alloy formation as well as nano-structuring is currently underway to reduce the thermal conductivity and improve the *ZT*.