

元素添加による窒化物薄膜の特性制御

～極性の制御から導電性の制御まで～

- ▶ 反応性スパッタリングを使ったによるウルツ鉱型窒化物の特性制御への元素添加
- ▶ 元素添加はウルツ鉱型窒化物の極性制御に有効
- ▶ ウルツ鉱型窒化物の導電性も元素添加による制御にも利用可能

Wurtzite Nitride thin films as the future materials

- Wurtzite-structured AlN and ScAlN are promising materials for future next-generation electronic devices, including radio frequency (RF) filters.
- Stacking Al-polar/N-polar piezoelectric thin films resulted in RF filter that can work at much higher frequency → Polarity control technology is important.
- Electrode material also affects the performance of RF filter → Conductivity control technology is needed.

Aluminum Nitride (AlN)

- Wurtzite structure
- Ultra-wide band gap (6.0 eV)
- Moderate piezoelectricity
- Very low resistivity (insulator)

Scandium Aluminum Nitride (ScAlN)

- Piezoelectricity
- Ferroelectricity

Applications

RF filters for wireless communication

Piezoelectric layer → Polarity control

Electrode layer → Conductivity control

Improvement is necessary to realize frequency filter for 5G and 6G network range

• Allow the realization of RF filter with higher frequency and wider bandwidth

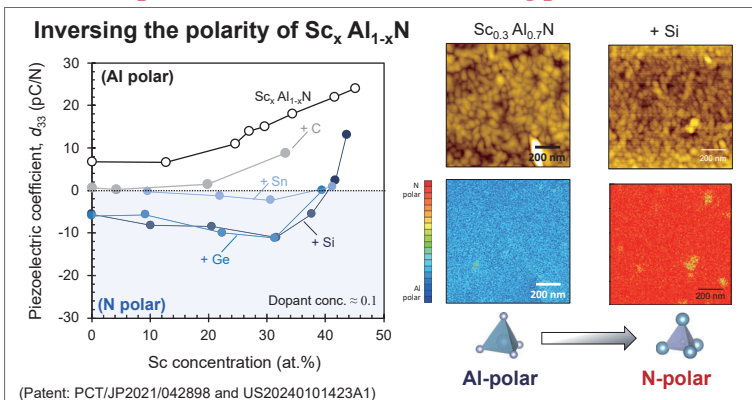
• Electrode material also affect the performance

Sensor Time of Flight Sensor (NTT) TOKAI J.V.

Power device AlN-based Transistor (NTT press release 2022.2.V)

Microphone High SNR microphone (Vesper Technologies co. GSP-P.V)

Polarity Control Technology



- Addition of element such as silicon (Si) or germanium (Ge) can be used to control the polarity of wurtzite nitride (AlN or ScAlN) thin films.
- Addition of element that can promote the formation of cation vacancy (V_{Al}) is the key to control polarity.
- Polarity control can be done not only by selecting the appropriate dopant but also by adjusting the concentration of the dopant as well as the concentration of Sc (In case of ScAlN).

Conductivity Control Technology

- The electronic conductivity of wurtzite structured AlN (resistivity : $10^{14} \sim 10^{10} \Omega\text{cm}$) can be improved by addition of element, such as Au or MgAu into AlN. The resulting resistivity of MgAuAlN at RT is $10^{-5} \Omega\text{cm}$.
- The ratio and concentration of co-dopants or dopant is important to improve conductivity while simultaneously maintaining wurtzite structure.

