

**AlCl<sub>3</sub> 와 TiCl<sub>4</sub> 전구체로부터 형성된 Ti<sub>0.83</sub>Al<sub>0.17</sub>N 원자층 증착 박막의  
열역학적인 고려**

(Thermodynamic consideration to atomic layer deposition of Ti<sub>0.83</sub>Al<sub>0.17</sub>N thin  
films from AlCl<sub>3</sub> and TiCl<sub>4</sub> precursors)

Korea Advanced Institute of Science and Technology (KAIST)

Yong Ju Lee and Sang-Won Kang

TiN has been extensively studied as a diffusion barrier in advanced integrated circuit devices suggesting that TiN can be introduced without any difficulties into existing or future ultra-large-scale processes[1]. However, TiN films oxidize noticeably at temperatures above 500°C forming TiO<sub>2</sub> (rutile structure)[2]. Recently, ternary compounds of Ti-X-N films with superior oxidation resistance have been developed and investigated as an alternative to TiN. Of these ternary titanium nitride materials, Ti-Al-N is the best-studied[3] because it shows excellent anti-oxidation properties. In this study we have investigated the Ti-Al-N films deposited by plasma-enhanced atomic layer deposition (PEALD) on the basis of thermodynamic consideration.

Ti-Al-N films were synthesized from TiCl<sub>4</sub>, AlCl<sub>3</sub>, NH<sub>3</sub>, N<sub>2</sub>, Ar, and H<sub>2</sub> at 350°C using various plasmas. A hydrogen plasma was used as a reducing agent for AlCl<sub>3</sub> and TiCl<sub>4</sub> and to improve film quality. For Ti<sub>0.83</sub>Al<sub>0.17</sub>N films, the growth rate was saturated at 0.047 nm/cycle, which made it easy to control the film thickness concisely. Ti<sub>0.83</sub>Al<sub>0.17</sub>N films had excellent surface morphology, which resulted from the self-limiting surface reactions. Ti<sub>0.83</sub>Al<sub>0.17</sub>N films are polycrystalline with a NaCl-type structure and good oxidation resistance when O<sub>2</sub> annealed at 650°C for 30 min.

References

- [1] S. R. Kurtz and R. G. Gordon, *Thin Solid Films*, **140**, 277 (1986).
- [2] S. Ikeda, S. Gilles, and B. Chenevier, *Thin Solid Films*, **315**, 257 (1998).
- [3] M. Juppo, P. Alen, M. Ritala, and M. Leskela, *Chem. Vap. Deposition*, **7**, 211 (2001).