【T-01】

Low-temperature atomic layer deposition of AlN thin films using plasma interactions

Yong Ju Lee and Sang-Won Kang
Korea Advanced Institute of Science and Technology (KAIST)
Department of Materials Science and Engineering

Aluminum nitride (AlN) is a wide band gap (6.2 eV) III-V compound with a high thermal conductivity (320 W/mK at 300K),(1) a high thermal stability (2500K)(2) and a high electric resistance (1013Ωcm).(3) It is utilized as a electric insulation with heat radiation. Particularly because the surface acoustic wave (SAW) velocity of AlN along the c-axis is highest (6x103m/s)(4) among those of piezoelectric materials, AlN thin films have attracted increasing interest for application to SAW filters operating at over 1 GHz in wireless communications technology. But the deposition temperature is too high,(5) which degrades the substrate interfaces during deposition. Consequently, the growth of AlN films at low temperatures has become increasingly important and valuable. In this study, the AlN thin films were deposited by plasma-assisted atomic layer deposition (ALD) at low substrate temperatures.

AlN films were deposited on the p-type Si (100) substrate using a sequential supply of AlCl3 carried by N2 gas, a purge period with Ar/H2, then an NH3/H2/Ar plasma, and finally a purge period with Ar/H2. By the repetition of this cycle, AlN films were prepared. The deposition temperature is mostly 350 ℃, and the deposition pressure and RF power are 3 Torr and 150 W, respectively.

The AlN thickness is proportional to the number of cycles. By this result, we can exactly control the thickness by the number of cycles instead of inexact process pressure or time as in CVD. The concentration of AlN is about Al0.48N0.52, and the chlorine concentration is below the AES limit, 3%. In addition, films are grown by a layer-by-layer manner. Therefore, we successfully obtained Al0.48N0.52 thin films using ALD with low temperatures.

[References]

1. G. A. Slack, R. A. Tanzilli, R. O. Pohl, J. W. Vandersande, J. Phys. Chem. Solids, 48, 641 (1987).

2. T. J. Mroz, J. Am. Cerem. Soc. Bull., 71, 782 (1992).
3. T. Y. Sheng, Z. Q. Yu, G. J. Collins, Appl. Phys. Lett., 52, 576 (1988).
4. M. T. Duffy, C. C. Wang, G. D. O'clock, S. H. MacFarlance III, P. J. Zanzucchi, J. Electron. Mater., 64, 166 (1994).
5. R. D. Vispute, V. Talyansky, R. P. Sharma, S. Choopun, M. Downes, T. Venkatesan, Y. X. Li, L. G. Salamance-Riba, A. A. Iladis, K. A. Jones, J. Appl. Surf. Sci., 127, 431 (1998).