PLD를 사용하여 Ti doped K(Ta,Nb)O3 thin film의 유전특성을 위한 annealing 효과

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The effect of annealing for dielectric properties of Ti doped K(Ta,Nb)O_3 thin film using PLD

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Abstract

The epitaxial $KTa_{0.524}Nb_{0.446}Ti_{0.03}O_3$ films with 3% Ti were investigated. Titanium (+4) substitution on the Nb/Ta site should reduce dielectric losses of KTN: Ti film by introducing an acceptor state. This acceptor state traps electrons due to oxygen vacancies that form during oxide film growth. KTN:Ti films were grown using pulsed laser deposition, and then annealed at different temperatures in oxygen ambient. The crystallinity, and surface morphology of KTN:Ti film were investigated using x-ray diffraction, and atomic force microscopy. The dielectric properties of Ti doped KTN films measured for unannealed and annealed films will be reported. Tunability and dielectric loss of as-deposited KTN:Ti film were determined to be 10% and 0.0134, respectively. For films annealed at 800°C and 900°C, the dielectric loss decreased but with a decrease in tunability as well.

Introduction

The application fields of ferroelectric materials is FRAM, optical wave-guide, and tunable microwave device. The good candidate for microwave application due to its low dielectric loss and composition dependent Curie temperature Tc. KTaO3 is incipient ferroelectric with cubic structure. (ao = 3.9885Å) KNbO3 is ferroelectric material with 4 different phases along with different phase transition temperature. KTaO3 and KNbO3 form complete solid solution. (KTa1 -xNbxO3) Nb-doped KTaO3 yields a ferroelectric Tc = 625x + 32, x > 4.7 at%

Experimentation and result

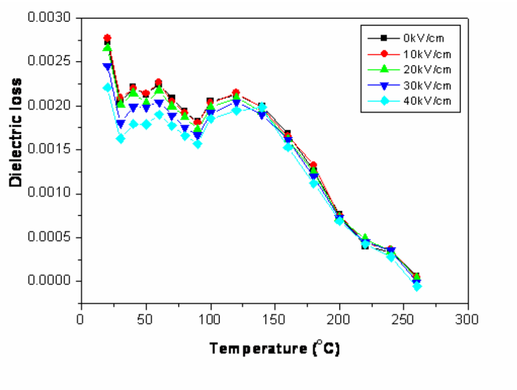

Figure 1. Dielectric loss of KTN:Ti film annealed at 900oC as a function of temperature

Tan δ decreased as measurement temperature increased and ranges 0.0026 to 0.0002 for all measurement temperatures

Difference in loss at RT is 13% ((Loss(E0)-Loss(Emax))/Loss(E0) x 100)

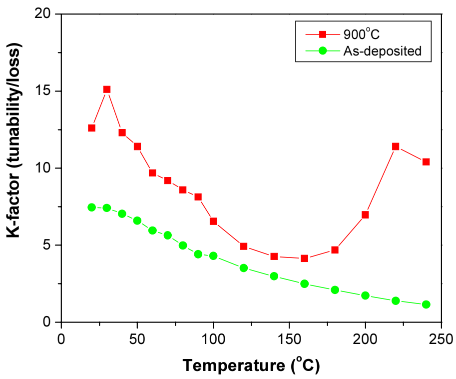

Figure 2. FOM of as-deposited and annealed KTN:Ti films

Figure 1 of merit (FOM) of KTN:Ti film annealed at 900oC is higher than that of as-deposited

FOM known as K-factor Although tunability of annealed KTN:Ti film is smaller than that as-depostied one, relatively low dielectric loss in annealed KTN:Ti film has a major effect for high FOM in annealed KTN:Ti

Conclusion

Study of dielectric properties of annealed KTN:Ti films

Annealing of KTN:Ti films lower tunability and dielectric loss than as – deposited KTN:Ti film

Annealing in O2 and acceptor Ti ions compensate donor state due to oxygen vacancies

Although tunability of annealed KTN:Ti film is smaller than that as-depostied one, relatively low dielectric loss in annealed KTN:Ti film has a major effect for high FOM in annealed KTN:Ti

Reference

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