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EPITAXIAL GROWTH OF GARNET FILMS FOR BUBBLE MEMORY DEVICES

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By the recent progress of magnetic bubble domain technology, it is noted that the epitaxially grown garnet films must have high data rates and highly stable temperature coefficient over a wide range of temperature for the bubble application.

We would like to report here, for these purposes, new development of the magnetic garnet material's preparation which have higher Curie temperatures and contain low concentration of cations with an unquenched magnetic orbital momentum.

Films of composition $(Y,Re)_{3-x}Ca_xFe_{5-x}Ge_xO_{12}$ have excellent magnetic properties such as high domain mobility (larger than 1000 cm/sec-Oe) and comparatively high Curie temperature.[1] The substitution of Ca-Ge ions into YIG films does not greatly change the lattice parameter so the matching of the lattice parameter to that of GGG substrate is very good whenever the substitution value x varies widely.

The distribution coefficient of Ca^{2+} or Ge^{4+} ions are very important factor for epitaxial growth of the films, which has not been clear yet.

We have tried to clearfy the distribution mechanism and coefficients of the films containing both Ca^{2+} or Ge^{4+}. The substituted value, x, were deduced from measurements of Curie temperatures with varying the concentration of each ions in the melt. The influence of Pb^{2+} contamination in the films which disturb the precise determination of x, is eliminated by discussing the fluorescent X-ray analysis.

The experiments were performed with three series of the melt which were constructed by different mole ratios of the constituents.

Series A: gradual addition of $CaCO_3$ into excessively melted GeO_2 solution in the $PbO-B_2O_3$ flux melt.

Series B: gradual addition of GeO_2 into excessively melted $CaCO_3$ solution.

Series C: gradual addition of GeO_2 into properly melted $CaCO_3$ solution up to the substituting value x reaches nearly 1.

The values of the distribution coefficient of ions were deduced from usual notation:

$$\alpha(Ca) = \left(\frac{Ca}{Re + Ca} \right)_{film} / \left(\frac{Ca}{Re + Ca} \right)_{melt}$$

$$\alpha(Ge) = \left(\frac{Ge}{Fe + Ge} \right)_{film} / \left(\frac{Ge}{Fe + Ge} \right)_{melt}$$

These results were; (i) The distribution coefficient of Ca^{2+} in series A was nearly constant and also the same to that of Ge^{4+} in series B. (ii) The value of $\alpha(Ge)$ was larger than $\alpha(Ca)$. (iii) For series C, $\alpha(Ge)$ was abruptly decreased at the low concentration range of GeO_2, but as the concentration increased, the value of $\alpha(Ge)$ decreased and reached to constant value asymptotically. (Fig. 1)

For epitaxial growth of Ca-Ge substituted bubble films, the addition of large amount of $CaCO_3$ into the melt was not desirable. It changed the state of flux melt to have higher viscoucity. In conclution, by using the result of (iii), it became controllable to grow high quality Ca-Ge substituted films.

That is desirable temperature coeff.,high mobility and high data rates, and no defects films.

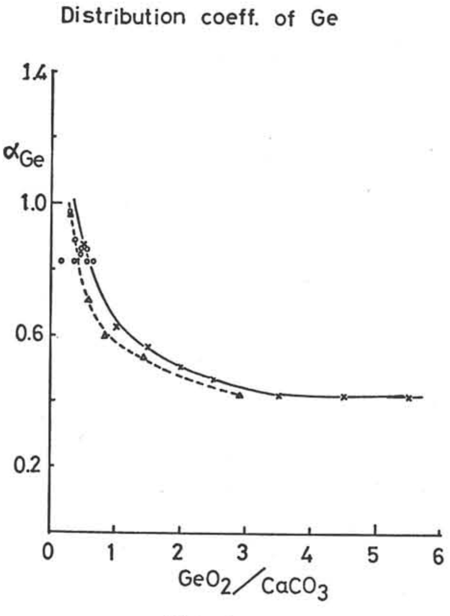

Fig. 1

Reference

1) W. A. Bonner et. al., Mat. Res. Bull. 8 (1973) 1223