Digest of Tech. Papers The 8th Conf. (1976 International) on Solid State Devices, Tokyo

B-5-6

Thermal Oxidation of GaAs

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Introduction: Two kinds of the kinetics of thermal oxidation of GaAs have been reported. However it is not understandable that the so-called parabolic relationship held relatively low temperature oxidation, consequently for thin oxide film, but the so-called linear relationship held for relatively high temperature oxidation, consequently for thick oxide film.[(1)(2)(3)]

Therefore the thermal oxidation kineties of GaAs and furthermore technique making thick uniform oxide film grow on GaAs wafers are being pursued by the authors. This will be useful to get thick oxide films for planar technology of GaAs and for passivating GaAs surfaces.

Experimental: The schematic diagram of the set up for oxidation is illustrated in Fig. 1 and nitrogen was used as the carrier gas of HF and/or H_2O vapor.

The mechano-chemically polished GaAs wafers were etched by the mixture, H_2SO_4 : H_2O_2 : H_2O (4:1:1 in volume ratio) and rinsed in deionized water. For (100) wafers dipping into conc. HF (49%) or thorough cleaning up by ultrasonic for hours was required for making the oxide film uniform. Other oxidation condition are indicated in Fig. 1 and 2.

Results: Major results obtained in this work are listed below.

(1) Oxidation rate; As shown in Fig. 2 the thermal oxidation rate is enhanced with presence of H_2O vapor in the oxidizing atomosphere and the linear relationship holds.

(2) Dependence of Surface Orientation and Pre-treatment; Effect of H_2O and HF vapor differs by the surface orientation of the wafers and thermal oxidation of (111) and (110) wafers follow the linear relationship with the presence of H_2O vapor only. For (100) wafers the pre-treatment before the oxidation much influenced the oxidation rate. Thermal oxidation of samples, which have been kept in methanol or acetone after chemical etching, follows the parabolic law, and is not much influenced with the presence of H_2O vapor. On the other hand oxidation of samples, which have been dipped into HF or cleaned up with ultrasonic follows the linear relationship, but in dry oxygen the growth rate significantly drops at about 1000 Å thickness. Even wet oxygen the decrease of the growth rate was found but could be avoided by introducing HF vapor into HF vapor.

(3) Dopant dependence; Within the experimental errors the oxidation rates are independent of the kind of dopants such as Si, Sn and Te for (100) wafers.

(4) Impurity concentration dependence; The oxidation rate of the wafers with higher impurity concentration is slightly larger than that of the wafers with lower impurity concentration. Further studies on this matter are now going on.

(5) Chemical properties; The oxides grown by this process are easily dissolved in HF and HCl, while the oxides grown by (P) in Fig. 2 are dissolved in boiling HCl.

Conclusion: The presence of H_2O vapor or H_2O and HF vapor in the oxidizing atomosphere greatly enhances the thermal oxidation of GaAs. The linear relationship holds for the oxidation and oxide film thicker than 1 μm can be obtained. The film is easily etched by HF and compatible with the photolithographic processes. Electrical properties of the film and the interface are being studied.

Acknowledgement: This work has been done as a part of the special research project "Surface Electronics". The authors thank Ministry of Education and Research for the financial support.

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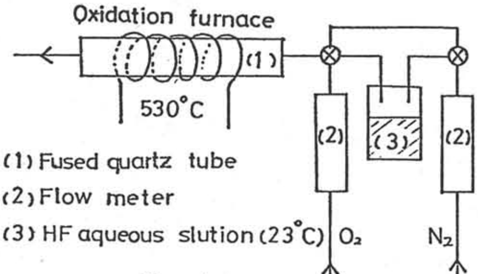

Fig. 1

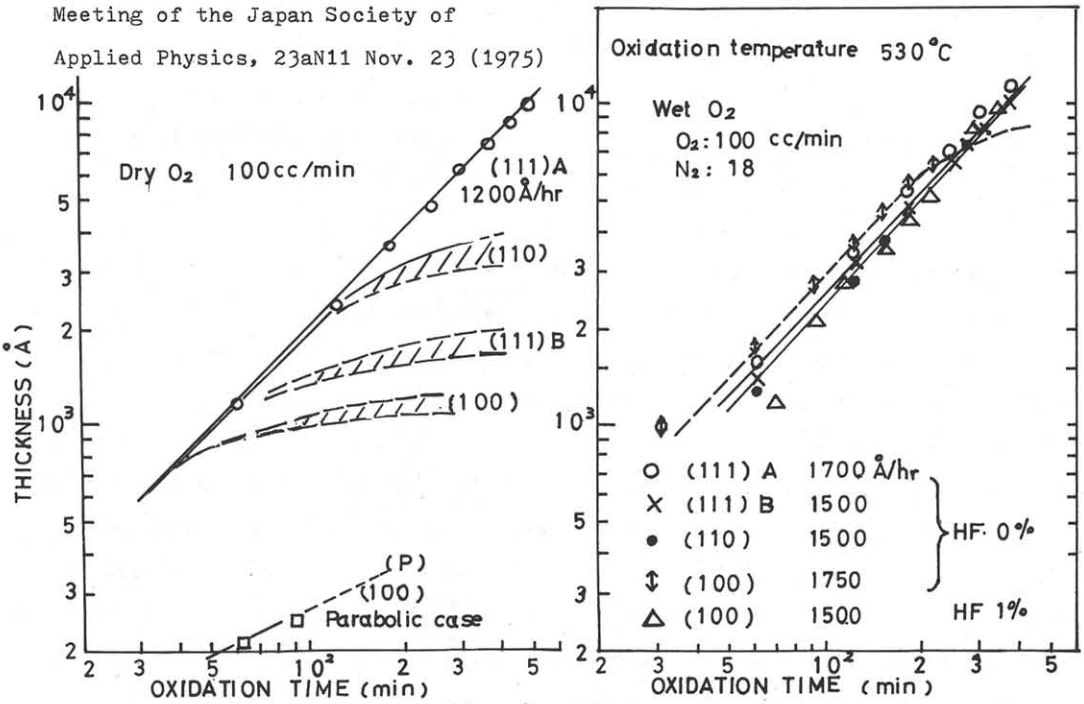

Fig 2

* This is not the concentration in the oxidizing atmospnere but the concenration of HF in the aqueous solution as the source of HF