Topics

Silica Mesoporous Thin Films: Pore Orientation Control and Application

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1. Introduction

By combining silica mesoporous thin films having uniform pores of nano-size with semiconductor micro-processing technology, a method was developed to control the orientation of the pores. Retaining the resistance to semiconductor processing, application of the silica thin films to functional devices was studied.

2. Methodology

Using TMOS (Tetramethylorthosilicate) and an organic surface active agent (cetyl-trimethyl-ammonium chloride) as the starting materials, a precursor sol was prepared under acid conditions. To fill the micron-size grooves processed on the silicon substrate with this sol and form a film, the substrate is submerged and then extracted from under the sol[1]. The organic micelle in the precursor is oriented in the direction of dipping. Moreover, an attempt was made to cut out the desired form from the orientation controlled film by dry etching (RIE method). The characteristics of this film as a humidity sensor were evaluated.

3. Results

Fig. 1 shows the results of the cross sectional TEM observation of the pore orientation-controlled film in two directions. It was confirmed that the pores on the surface of the substrate are oriented in the direction of the grooves parallel to the direction of dipping. The film enables dry etching as with ordinary silica films and retains the original mesoporous structure after semiconductor processing. Being a porous silica film, it has a low dielectric constant of 1.8 and can also be used as an insulating film of low dielectric constant. As **Fig. 2** shows, the variation in the observed impedance reflected the variation in the dielectric constant against the water adsorption corresponding to the pore size. The response speed was considerably high, ranging from several to several dozen seconds.

4. Conclusion

Control of the macro-orientation of nano-size pores has been realized by developing a method of synthesizing silica mesoporous thin films. This control method enables the processing and introduction of a gas and liquid through the section during the semiconductor production. Application of this method to electron devices and sensors is expected.

Reference

1) Goto, Y., Sugimoto, N., Fukushima, Y., Imada, Y., Kubota, Y., Sugi, Y.; Mater, Res. Soc. Symp. Proc. 581 (2000), 423

(Report received on Nov. 1, 2000)

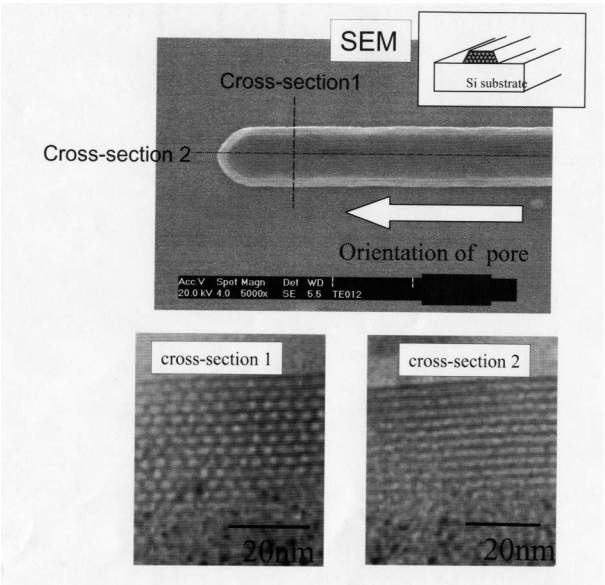

Fig. 1 TEM and SEM image of the mesoporous silica thin film on Si substrate.

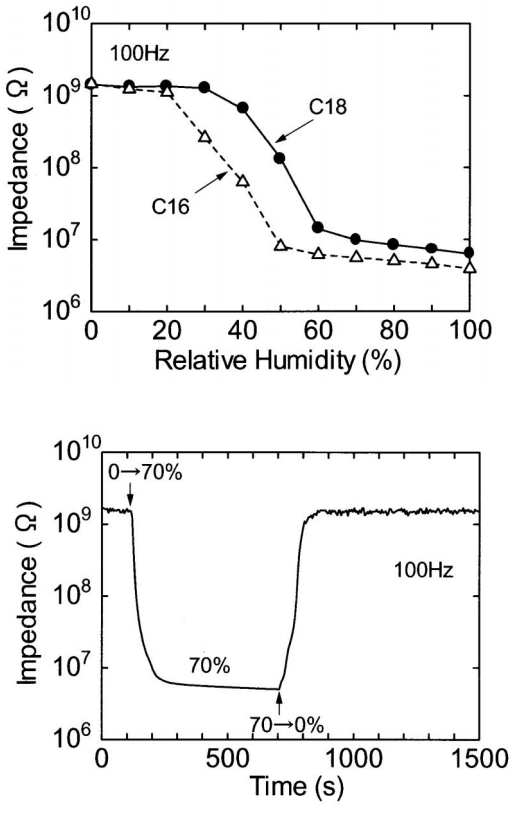

Fig. 2 Humidity sensor operation.