Curing Process of Silsesquioxane in Self-Organized Diblock Copolymer Template

Naoko Kihara, Kazutaka Takizawa, Hiroyuki Hieda
Corporate Research & Development Center, Toshiba Corporation
1, Kimukai-Toshiba-cho, Saiwai-ku, Kawasaki, 212-8582, Japan

In the case that a self-organized diblock copolymer pattern is applied as an etching mask template, one of the polymer components is required to have a high etching durability similar to that of silicon oxide. One suitable material for the purpose is a mixture of polystyrene -*b*-polyethyleneoxide (PS-PEO) and silsesquioxane.[1] After phase separation, the silsesquioxane component is located only in the PEO phase. In the subsequent baking treatment at high temperature, the organic component is decomposed to leave cured silsesquioxane pattern, which could be applied as etching-mask.
In this study, we investigated the curing process of the mixed component system, comparing thermal treatment and oxygen plasma treatment. Oxygen plasma treatment is more convenient for curing silsesquioxane than high temperature thermal treatment is. As shown in Fig. 1, a significant difference was observed between the plasma treatment and the thermal treatment. The plasma-treated film was shrank to 72% of the baked film. To investigate the difference, shrink behavior of PEO phase was investigated using mixture of PEO and silsesquioxane in various ratios. Broken lines in the Fig.2(A) indicate the residual thickness of silsesquioxane of the films, estimated from the remaining thickness of 100% silsesquioxane film. The residual thickness in the case of thermal treatment was larger than the estimated thickness, though the residual thickness in the case of plasma treatment remained around the same value as the estimated thickness of silsesquioxane itself. From the results, the remarkable difference in shrinkage is attributable to the hardening and decomposing process of silsesquioxane and PEO. The schematic image of the curing process is shown in Fig. 2 (B). In the case of thermal treatment, space attributable to PEO was still remained. In the case of plasma treatment, the space attributable to PEO was vanished during cure. From the results, higher-aspect mask pattern was obtained by thermal treatment than by plasma treatment.

1. Ho-Cheol Kim, Joy Cheng, Oun-Ho Park, Sang-Min Park, Ricardo Ruiz, Charles T. Black, Jed Pitera, Charles Rettner, Myron Flickner, Proc. SPIE **6921** (2008) 692129-1.

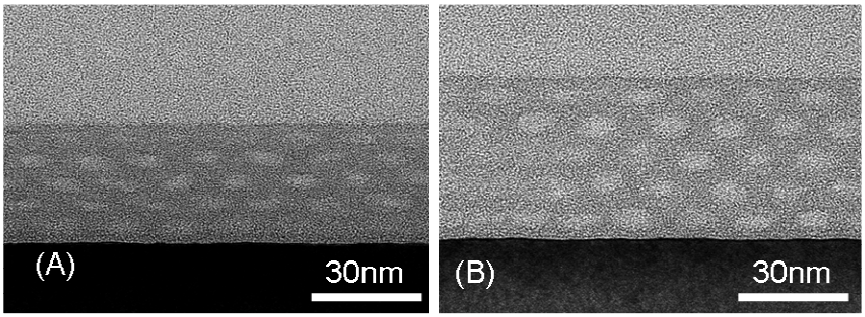

Figure 1. Cross-sectional TEM images of curing treatment.
(A) plasma treatment, (B) thermal treatment at 400°C for 2hr.
Molecular weight of PS-PEO was 10.3k and weight function of PEO/silsesquioxane was 0.16.

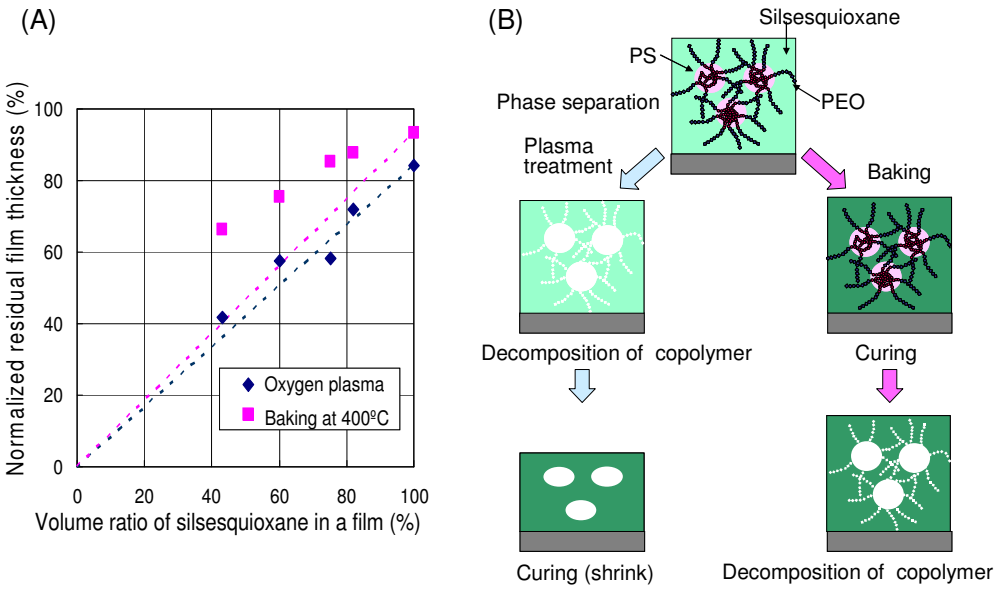

Figure 2 (A)Relationship between silsesquioxane volume in the film and residual thickness after curing treatment, comparing baking treatment and plasma treatment. Broken lines indicate the estimated residual thickness of silsesquioxane from the results of 100% silsesquioxane films treatment.
(B) Schematic image of curing sequence of PS-PEO and silsesquioxane mixture.