In silica and titania films prepared by low speed dip coating

Micropatterning

(Kansai University, Department of Chemical and Life Sciences) Hiroaki Uchiyama, Masataka Hayashi, Daisuke Shimaoka, and Hiromitsu Kozuka

Spontaneous pattern formation on silica and titania dip-coating films prepared at extremely low substrate withdrawal speeds /•H. Uchiyama, M. Hayashi, D. Shimaoka, H. Kozuka/ / Linear patterns were spontaneously formed on the dip-coating silica and titania films prepared from Si(OCH3)4 and Ti(OC3H7 i)4 solutions, respectively. In both films, the pattern formation occurred at extremely low substrate withdrawal speeds below 1.0 cm min-1, where the film thickness increased with decreasing substrate withdrawal speed for dip-coating. The linear patterns on micrometer scale were arranged perpendicular to the substrate withdrawal direction. The values of RZ (10 point height of irregularities) and *S* (mean spacing of local peaks) of the patterns increased with decreasing substrate withdrawal speed.

Contact: Email: h_uchi@kansai-u.ac.jp

[Introduction] In recent years, periodic structures formed by the spontaneous arrangement and alignment of atoms and molecules have been attracting attention.
The authors have reported that the formation of micro-order irregularities is observed in the dip-coated films at a withdrawal speed of 1 cm min-1 or less.
In this study, the researchers found that a stripe pattern perpendicular to the pulling direction was periodically formed by dip coating from a titanium alkoxide solution.
In silica and titania gel films prepared by dip coating, the viscosity of the precursor solution and the substrate withdrawal speed during dip coating were
By changing the temperature, we were able to control the shape and size of the muscle mass pattern that developed on the gel film surface.

[Experimental method] Si(OCH3)4 : H2O : HNO3 : C2H5OH : poly(vinylpyrrolidone) K90 (PVP K90) = 1 : 2 : 0.01 : 20 : 0.5, Ti(OC3H7 i A precursor solution of
4:acac:H2O:HNO3:C2H5OH:PVP K90 = 1:1:2:0.2:30:0.5 (molar ratio) was prepared at room temperature and used as a coating solution for dip coating on a Si (100) wafer.
Silica and titania gel films were prepared by ion beam sputtering (pulling speed: 0.02–1.0 cm min-1).
The structure was evaluated by the method.

[Results] For both silica and titania gel films, the thickness decreased by decreasing the withdrawal speed from 1.0 cm min-1 to 0.02 cm min-1.
The thickness of the silica film was larger than that of the titania film. The gel film prepared at a pulling speed of 1.0 cm min-1 was smooth, but
At a lifting speed of 0.3 cm min-1 or less, stripes perpendicular to the substrate lifting direction were observed on the gel film surface.
The formation of a pattern was confirmed (Figure 1). As the pulling speed decreased, the stripe pattern
The height and spacing increased. Also, the size of the patterns increased with silica and titania.
No significant differences were observed.

At a withdrawal speed of 1.0 cm min-1 or less, coating occurs mainly at the meniscus near the liquid surface.
As the solvent evaporates from the gel film, the gelation of the film progresses at the meniscus.
In addition, the coating liquid at the tip of the meniscus is concentrated by evaporation of the solvent.
The coating liquid is sucked up to the tip of the meniscus by surface tension, and the gelled part is further
This formation of the raised portion at the tip of the meniscus occurs repeatedly during dip coating.
It is believed that the stripe pattern perpendicular to the substrate lifting direction was formed by the return of the substrate.
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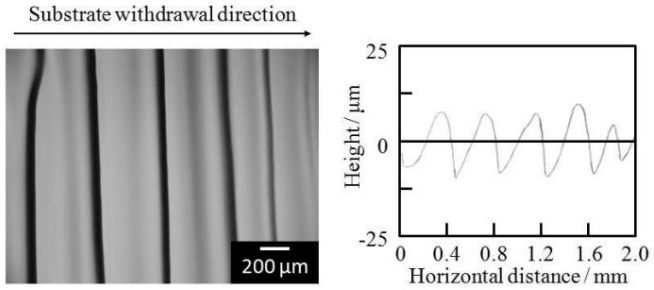

Fgire 1. Optical micrograph and transverse profile of titania films prepared by dip-coating at the substrate withdrawal speed of 0.05 cm min-1.