5th Multidisciplinary International Student Workshop (MISW2013)
August 8-9, 2013, Tokyo Institute of Technology, Tokyo, Japan

Extended Abstract

Alkaline-developable Positive-type Photosensitive Polyimide based on Fluorinated Poly(amic acid) and Fluorinated Diazonaphthoquinone

Yusuke Inoue*, Tomoya Higashihara** and Mitsuru Ueda***

* Department of Organic and Polymeric Materials, Graduate School of Science and Engineering, Tokyo Institute of Technology, 2-12-1, O-okayama, H-120, Meguro-ku, Tokyo 152-8552, Japan

** Department of Polymer Science and Engineering, iFront Leading Doctoral Graduate School Program, Yamagata University, 4-3-16, Jonan, Yonezawa, Yamagata 992-8510, Japan

***Department of Chemistry, Kanagawa University, 3-2 7-1, Rokkakubashi, Kanagawa-ku. Yokohama 221 -8686, Japan

e-mail: mueda@kanagawa-u.ac.jp

I. INTRODUCTION

Recently, positive-type photosensitive polyimides (**PSPIs**) as a stress buffer and insulation layers have been receiving much attention. However, development of positive-type **PSPIs** is a limited success because the dissolution rate of poly(amic acid)s (**PAAs)** in a 2.38 wt% aqueous tetramethylammonium hydroxide (TMAHaq) solution is too high to obtain a sufficient dissolution contrast between unexposed and exposed areas In a previous paper [1], we reported an alkaline-developable positive-type **PSPI** based on fluorinated poly(amic acid) (**FPAA**), **PAA**, and fluorinated diazonaphthoquinone (**FDNQ-1**) as a photoactive compound. The cast film spontaneously formed phase-separated double layers during prebaking, consisting of a thin top layer of **FPAA** containing **FDNQ-1** and a thick bottom layer of **PAA**, where fluorinated monomers were used to reduce the dissolution rate of **PAA** to the TMAHaq solution. In this work, a more facile **PSPI**, that is, an alkaline developable positive-type **PSPI** consisting of the **FPAA** obtained from 4,4'-hexafluoroisopropyridene-bis(phthalic anhydride), 4,4'-oxydianiline, and **FDNQ-1**, which is a single layer **PSPI**, has been developed.

II. EXPERIMENTAL

A mixed solution of **FPAA** and **FDNQ-1** was spin-coated on a silicon wafer and prebaked, inducing a **FDNQ-1** rich surface, which was supported by measurement of the contact angle of water on the films. And then, This **PSPI** film was exposed to irradiation at a wavelength of *i*-line with changing an exposure dose, development with 2.38 wt% TMAHaq for 10 sec and rinsing with water.

III. RESULTS AND DISCUSSION

The contact angles of water to the **PSPI** films gradually increase as the PB temperature increases, indicating that segregation of **FDNQ-1** is effectively promoted during PB process, that is, the surface of the film tends to be covered by **FDNQ-1** with a lower surface energy. Incidentally, the **PSPI** film showed a high sensitivity of 45 mJ/cm^2 and excellent contrast (%) of 10 when it was exposed to *i*-line and developed with a 2.38 wt% TMAHaq. A clear positive pattern of a 8-μm line and space was obtained on a film when exposed to 120 mJ/cm^2 of *i*-line by a contact printing method.

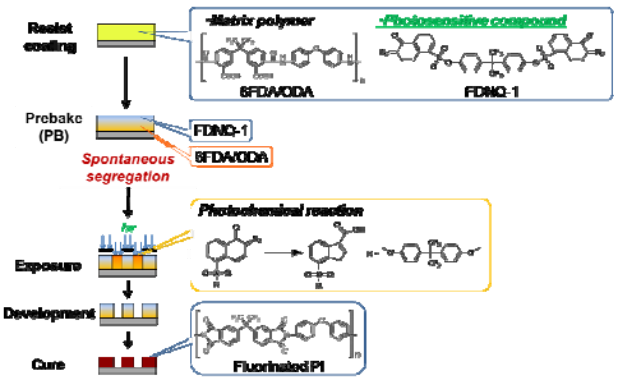

Figure 1. Patterning process of the resist based on FPAA and FDNQ-1

.

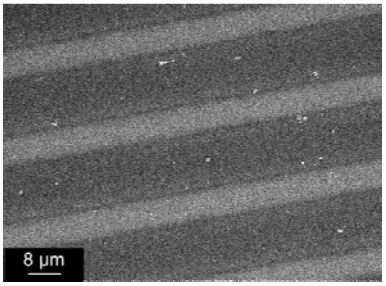

Figure 2. SEM image of the positive-patterned PI film (3.0 kV x 1.30 k).

REFERENCES

[1] Y. Inoue, Y. Saito, T. Higashihara and M. Ueda, "Facile Formulation of Alkaline-developable Positive-type Photosensitive Polyimide Based on Fluorinated Poly(amic acid), Poly(amic acid), and Fluorinated Diazonaphthoquinone" *Journal of Materials Chemistry C*, pp. 2553–2560, February 2013.