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Development of Optical Linear Polarizer Consisting of Polyimide Blend Film and Uniformly Oriented Silver Nanorods

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Fluorinated Polyimides (FPIs) are noticeable materials for optical devices because of their high thermal stability and high transparency in the visible-near-infrared (NIR) region. In addition, precipitation of metal nanoparticles in FPIs using organosoluble metal salts as source materials is versatile method to control their optical properties, such as absorption, refractive indices, and birefringence [1-5]. In this study, uniaxially drawn phase-separated polyimide (PI) blends (Fig. 1) were used as templates for the precipitation of zero-valent silver nanorods. Submicron-scale phase-separation was observed in precursor films, and silver ions were preferentially concentrated in the dispersed phase containing sulfonic acids due to their high hydrophilicity. Figure 2 shows the cross-sectional TEM images of a uniaxially drawn silver-dispersed PI blend film prepared under optimized conditions. The uniaxially-deformed dispersed phase efficiently functioned as a nanoreactor, and uniformly oriented silver nanorods (longer axis < 480 nm) exhibiting high aspect ratios (< 5) were precipitated by thermal drawing at high temperatures over 400°C. Figure 3 shows the polarized transmittance spectra of a silver-dispersed PI blend film. The film exhibits significantly high dichroic ratios (>300:1) in a wide range of NIR (λ =1.4–1.8 μm). In addition, the film is 19 μm-thick, which is sufficiently thin for reducing excess losses caused by the insertion or setup into optical devices. The film is tough, flexible, and tractable for insertion. Hence, the hybrid system based on PI blends and silver-nanorods and the procedures thus designed are promising for fabrication of flexible thin-film polarizers applicable to optical devices for photonics and telecommunications.

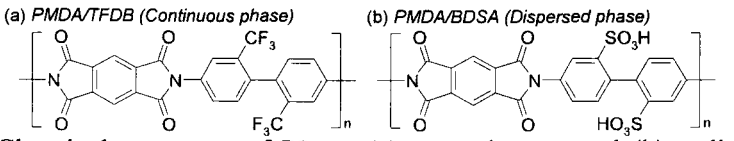

Fig. 1 Chemical structures of PIs as (a) a continuous and (b) a dispersed phase in PI blend.

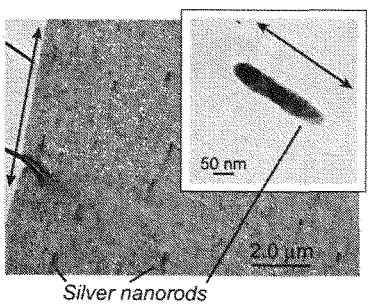

Fig. 2 Cross-sectional TEM images of a silver-dispersed PI blend film prepared under optimized conditions. Arrows denote the drawing direction.

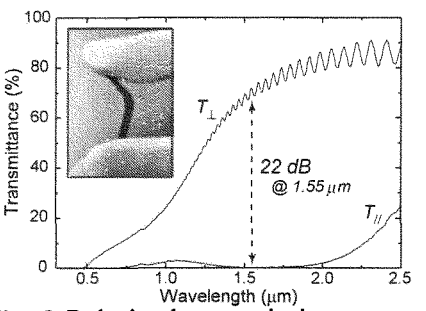

Fig. 3 Polarized transmission spectra of a uniaxially drawn silver-dispersed PI blend film, and its appearance.

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