HIGHLY-STRETCHABLE AND WATER IMPERMEABLE THERMALLY-GROWN SILICON DIOXIDE THIN FILM WITH WAVY STRUCTURES

Na-Hyang Kim, School of Materials Science and Engineering, UNIST (Ulsan National Institute of Science and Technology), Republic of Korea
nahy0520@unist.ac.kr
Hangeul Kim, School of Materials Science and Engineering, UNIST (Ulsan National Institute of Science and Technology), Republic of Korea
Ju-Young Kim, School of Materials Science and Engineering, UNIST (Ulsan National Institute of Science and Technology), Republic of Korea

To ensure chemical stability and long-term operation, organic electronic devices require encapsulation layer with low water vapor transmittance rate because organic components in organic electronic device are vulnerable to humidity. Encapsulation of commercialized OLEDs are rigid glass and epoxy resin, which are not suitable for flexible devices requiring high flexibility. TFE (thin-film encapsulation) technique has been studied for flexible device encapsulation. Amorphous materials are selected for TFE materials because they are dense and transparent and do not have fast diffusion paths like grain boundary. Thermally-grown silicon dioxide, oxidized from single crystal silicon substrate at high temperature, has ultra-low water vapor transmittance rate due to high density without pinholes and defects. However, the thermally-grown silicon dioxide thin films have a low elastic limit (< 1%) and show brittle fracture alike typical amorphous materials. For that reasons, it is necessary to improve the mechanical properties of the thermally-grown silicon dioxide thin film for flexible encapsulation. In this study, we tried to improve the stretchability by applying the wavy structure to thermally-grown silicon dioxide and developed the wavy structure texturing of single crystal silicon substrate by using photo-lithography and various etching process. we fabricated a highly-stretchable wavy thermally-grown silicon dioxide TFE by oxidizing wavy textured crystalline silicon substrate. Also, we carried out cyclic tensile test of submicron scale wavy thermally-grown silicon dioxide films and defined the elastic limit, and the stretchability. And then, we analyze the enhancement of stretchability by finite element analysis on the wavy and flat thermally-grown silicon dioxide TFE and discussed about the correlation between the improvement of stretchability and wavy structure.