Effect of In-Situ Heat Treatments on PVDF Film Characteristics Deposited by Using Atmospheric Pressure Plasma Synthesis

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In recent, the development trends of energy storage devices, will be stretchable, bendable, and portable device with light weight in the field of flexible devices, including nanogenerator and sensors. Thus, piezoelectric polymers have received attractive attention for their application [1]. Among of these piezoelectric polymers, polyvinylidene fluoride (PVDF) and its copolymers have been mostly studied due to specific properties. The PVDF thin film is usually used by solution-based synthesis, such as a electrospinning and spin casting [2]. However, these methods are unsuitable for applying the field of flexible devices due to their problems, such as complex, dangerous, and heating procedures according to the chemicals. To solve these problems, it is necessary to develop new processes based on low-pressure and atmospheric pressure plasma (APP) processes. Among these plasma processes, the low-pressure plasma have the biggest disadvantages in industrial applications, including the large equipment, high cost, and difficulty in transmitting heat on film owing to the use of a vacuum system. Thus, the APP process appears to be a promising method to deposit the polymer film on the point of view a simple, low cost, and heating-free process. For this reason, many studies has been currently investigated on the APP process for polymer film deposition [3,4].

Accordingly, to enhance the structural phase of PVDF thin film, this study investigated the effects of in-situ heat treatment on PVDF thin film characteristics during the APP process in terms of different heating temperatures (room temperature, 100, 150, and 200°C) using scanning electron spectroscopy (SEM), Fourier transforms-infrared spectroscopy (FT-IR), X-ray diffraction, and impedance analyzers. The PVDF thin film was deposited by APP process during 1 h using a mixed polymer solution composing of PVDF polymer nano powder and dimethylformamide (DMF) liquid solution. In addition, the in-situ heat treatment was performed through substrate heating on a hot plate while depositing the PVDF thin film by the plasma. Based on the FT-IR and SEM results, after PVDF thin film deposition at 150°C during 1 h, PVDF thin film was smoothly formed with PVDF nanoparticles and the DMF component in the form of bubbles was largely reduced. Moreover, in FT-IR spectra, two phases (α and β phases) were observed in in-situ heated PVDF film, which the peaks at 975 and 1402 cm^{-1} represent α-phase and the peak at 1072 cm^{-1} indicates β-phase. The detailed experimental results of PVDF thin films produced by in-situ heat treatment are currently being studied and will be described in detail.

Keywords: Atmospheric pressure plasma (APP), in-situ heat treatment, heating temperatures, polyvinylidene fluoride (PVDF) thin film, surface morphology, structural property

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