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A Study on Electric Field Dispersion Techniques of Epoxy-Nanocomposites for Application of High Voltage Power Apparatus

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Abstract : A new electric application method was developed to prepare epoxy/organoclay nanocomposite for the electrical insulation in the AC electric fields and it could be also used in the field of various viscous polymer/organoclay systems. The applied AC electric field condition was as follows; (1) inter-electrode distance: 40 mm, (2) application voltage: 3~11 kV, (3) frequency: 60~1,000 Hz, and (4) application time: 0~60 min. To characterize the epoxy/clay nanocomposite, WAXS and TEM analyses were confirmed. In order to explain how the organic modifier affects the exfoliation phenomena, a mechanism of the oscillating collision of the quaternary ammonium head was proposed and the effects of the AC voltage and frequency and the organoclay content were studied.

Key Words : AC Electric Fields Dispersion, Epoxy-Nanocomposites, TEM, X-RD, Hopping Current

1. 서 론

Multilayered silicates have been used as nano size in polymer nanocomposites and the most well-knowns are montmorillonite, saponite, hectorite, talc, mica, etc. Generally, they are naturally synthesized in bulk shape and they are pulverized into fine particles of ㎛ size. Therefore, to synthesize polymer nanocomposites, the multilayered ㎛ particle should be separated into sheet-like monolayers in the polymer matrix, whose dimension are (20~1,000)×(20~1,000)×1 nm^3. The driving force to separate them each other is given by polymer penetration through the interlayers of the silicate monolayers. The polymer chains are in the form of coil-like conformation in the interlayers and this result leads to the intercalated or exfoliated nonocomposites[8],[9]. However, it is very difficult for the polymer chains to penetrate into the hydrophilic interlayers. Therefore, it should render the interlayers or ganophilic by means of cation exchange with alkyl ammoniumions[9]-[12]. There are five synthetic methods to prepare polymer/organoclay nanocomposites: (1) in-situ polymerization, (2) direct melt intercalation, (3) solution intercalation, (4) direct layered silicate method and (5) dispersion and aggregation method [1]-[4]. In this paper, we developed a new electric field method for the preparation of thermoset/organoclay nanocomposite. The effects of voltage and frequency on the penetration process of the epoxy oligomers were studied in the epoxy/organoclay system, and the motion of the organic modifier in the intergallery of the clay was explained in the AC electric field.

2. 결과 및 토의

Electrophoresis is a separation technique that is based on the mobility of ions in an electric field. Positively charged ions migrate towards a negative electrode and negatively ones move to other side. The segments of proteins or DNA can also respond to the electric field because a protein has positive charge on amino-side end group and negative charge on acid-side end group or a DNA has a negative charge on phosphate group [17]. Therefore, we think, the positive quaternary ammonium group on the organic modifier being similar structure to the amino group of proteins may react to the electric field and if it would respond to alternating current (AC) in the intergallery of the clay minerals, the surrounding epoxy base resin can easily penetrate into the gallery. To confirm the oscillation motion of the organic modifier, the application of AC electric field to the epoxy base resin/organoclay mixture was conducted.

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