Process and characterization of an electrochromic film made of silica-polyaniline composite nanoparticle

Taejin Hwang*, HeungYeol Lee, Hyun-Jung Joo, TaiHong Yim
Surface Nanotechnology Team, Korea Institute of Industrial Technology (KITECH)

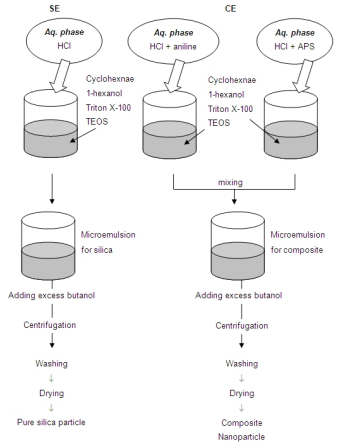
Abstract: Composite nanoparticles of silica-polyaniline were synthesized and tested as an electrochromic material. For the optical application, the size of the nanoparticle was intended to be less than 100 nm in diameter. The synthesis was done by using a microemulsion synthesis method where the silica-polyaniline composite nanoparticle was obtained by dispersing two acidic aqueous phases containing aniline and polymerization agent, respectively. Microstructure analysis such as TEM and BET surface area measurement showed the possibility that polyaniline is incorporated in porous silica structure. The composite structure of the particle was proved to enhance chemical stability of the prepared electrochromic film.

1.Introduction

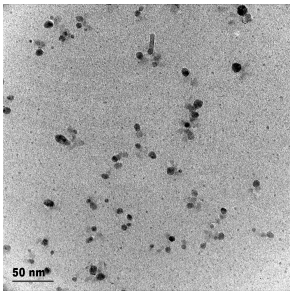
The most important requisites for the electrochromic material are response time and operation life time. Among the two types of electrochromic material, a) inorganic transition metal oxides (TMOs), b) organic conducting polymers, the conducting polymers are gaining more attentions, because of their faster response and longer operating life time. They are easy to process and have high degree of color tailorability. However, the operating life time of the conducting polymers is still limited to 10^6 cycles, and the limited operation life time is mainly due to a limited electrochemical stability of material [1-3]. Therefore, it is necessary to improve the stability to enhance the operating life time.
In this study, as a feasible way to enhance the electrochemical stability of polymer, an optical nanocomposite of silica and polyaniline in form of nanoparticle was tried using an inverse microemulsion. The electrochromic characterizations were also performed to see the electrochromic durability enhancement of the composite material.

2.Results

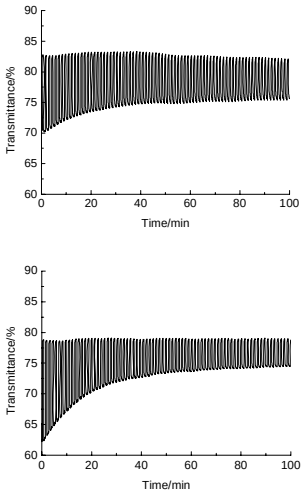
The composition of the prepared microemulsion was 65.4 wt% cyclohexane, 10.1 wt% Triton X-100, 20.3 wt% hexanol and 4.2 wt% aqueous phase. The size and shape of the particles obtained from the microemulsion were checked by TEM. The sizes of pure silica and composite particles were found to be around 10 nm.



Synthetic process for the composite nanoparticle



TEM photo of the composite nanoparticle



Comparison of operation life time for pure polyaniline and composite

Both the films made of pure polyaniline and of the silica-polyaniline composite particle were prepared

for the electrochromic characterization. Color contrast changes were measured and compared for the two films. While applying the switching potential between -0.2 V and +1.0 V with 30 seconds delay, the optical transmittance was monitored at 600 nm. Both the composite and the polyaniline showed a color contrast decrease with an increasing number of switching. The transmittance at the colored state was observed approaching to the fixed transmittance at the bleached state. The decrease of color contrast is much slower for the composite film. The color contrast of the composite film decreased from 15.1 % to 8.24 % after 80 switchings whereas that of the polyaniline film decreased from 18.5 % to 5.5 %.

3.Conclusion

The composite nanoparticle of silica-polyaniline was synthesized from the microemulsion solution with a composition 65.4 wt% cyclohexane, 30.4 wt% surfactant and 4.2 wt% aqueous phase. For the produced particles, microstructure analysis such as TEM and BET surface area measurement were performed. The results support that polyaniline would probably be formed in the pores of silica.
The composite particles were deposited as a film on the FTO-coated glass. From the comparison of the electrochromic properties with the pure polyaniline, the composite film showed enhanced electrochromic durability. This stability enhancement was interpreted as the suppression of formation of highly oxidized form.

References

〔1〕 Seeboth, A., J. Schneider, and A. Patzak, "Materials for intelligent sun protecting glazing" Solar Energy Materials & Solar Cells, 60, 2000, 263-277.
〔2〕 Mazeikiene, R. and A. Malinauskas, "Kinetic study of the electrochemical degradation of polyaniline", Synthetic Metals, 123, 2001, 349-354.
〔3〕 Mazeikiene, R. and A. Malinauskas, "Kinetics of the electrochemical degradation of polypyrrole". Polymer Degradation and Stability, 75, 2002, 255-258.