The Preparation of Nonaqueous Electrolytes Based on Quaternary Imidazolium Salts for EDLC

Jeeyoung Yoo, Kyungho Kim, Jaekun Kim, and Taewhan Yeu

Department of Chemical Engineering
Chungang University
Huksukdong Dongjakgu Seoul 156-756
Republic of Korea

Quaternary salts were prepared and characterized to use in an electrolyte for EDLC. Salts consisting of cation (1-methyl-3-ethyl imidazolium, 1,2-diethyl-3-methyl imidazolium, or tetraethylammonium) and anion (hexafluorophosphate, tetrafluoroborate, or perchlorate) had been synthesized. Quaternization reaction performed by using ethyl bromide as a quaternary agent. Unlike other halide agents, reaction was progressed in liquid phase at room temperature with high efficiency (above 90%). Hexafluorophosphate, tetrafluoroborate, or perchlorate was exchanged with bromide through double decomposition. For synthesized salts, purity was verified by IC and ICP, and structures were confirmed by 1H-NMR, 13C-NMR, and IR. Imidazolium salts had higher exothermic degradation temperature (350~400°C) than ammonium salts (250~300°C). Thermal stability was improved in order of PF₆⁻ > BF₄⁻ > ClO₄⁻ for anions and 1,2-dimethyl-3-ethylimidazolium > 1-methyl-3-ethylimidazolium > tetraethylammonium for cations. Ionic conductivities of electrolytes containing 1M of imidazolium salts in propylene carbonate (14.12 mS/cm at 25°C) were much higher than that of electrolytes containing 1M of ammonium salts (11.29 mS/cm at 25°C). Also, the electrolyte containing PF₆⁻ or BF₄⁻ was more conductive than the electrolyte containing ClO₄⁻. Such trends were confirmed with AC impedance analysis. Maximum solubilities of ammonium and imidazolium salts at room temperature were 1M and 1.6M in propylene carbonate. From cyclic voltammogram, the stability window of electrolyte based on imidazolium salts had about 2 V larger than that of electrolyte based on quaternary ammonium salts. As conclusion, the 1.6M of 1-methyl-3-ethylimidazolium hexafluorophosphate in propylene carbonate was superior to others in the thermal stability, ionic conductivity, and electrochemical stability windows. Rating characteristics of EDLC with imidazolium based electrolytes should be investigated in near future.