

Electrochemical Capture of Carbon Dioxide in an Ionic Liquid using N-Methyl-4,4'-Bipyridinium Cation

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There is considerable interest in cost-effectively capturing carbon dioxide (CO₂) due to an increase in CO₂ concentrations in the atmosphere. The recent commercially available techniques involve immobilized amines¹ for capturing CO₂ where the capture involves a carbamate formation via nucleophilic attack of the amine at the electrophilic carbon center of CO₂. We are especially interested in capturing CO₂ in an ionic liquid (IL) due to good ionic conductivity, wider electrochemical window, low vapor pressure and a reasonably good solubility of CO₂.^{2,3} Ishida et al. discussed the interaction between CO₂ and one electron reduced species of n-propyl-4,4'-bipyridinium cation in acetonitrile to form a stable CO₂ adduct.⁴ This contribution describes a preliminary examination of CO₂ capture using n-methyl-4,4'-bipyridinium (MeBipy) cation in the n-butyl-n-methylpyrrolidinium bis(trifluoromethylsulfonyl)imide (BMP⁺ TFSI⁻) ionic liquid.

The BMP⁺ TFSI⁻ ionic liquid was synthesized as described in Appetecchi et al.⁵ The electrochemical behavior of MeBipy cation was investigated in BMP⁺ TFSI⁻ ionic liquid on glassy carbon electrode using cyclic voltammetry (CV) in presence of N₂ and CO₂. Figure 1 shows the electrochemical reduction of MeBipy cation in an IL. The peaks at -1.15 V and -1.77 V correspond to one electron reductions of MeBipy cation to neutral MeBipy followed by MeBipy anion with their respective oxidation peaks at -1.08 V and -1.69 V. Figure 2 shows the electrochemical behavior of MeBipy cation in an IL in presence of CO₂. An increase in current at -1.14 V suggests an interaction between CO₂ and one electron reduced species of MeBipy cation. The detailed results showing an adduct formation with an increase in CO₂ concentration along with the reaction mechanism involved will be presented. Based on the reaction mechanism and various variables involved, an attempt to fit the experimental CV with software generated simulated CV will be discussed.

We have also explored the electrochemical behavior of different concentrations of MeBipy cation in presence of CO₂ at different scan rates. The results will be briefly discussed.

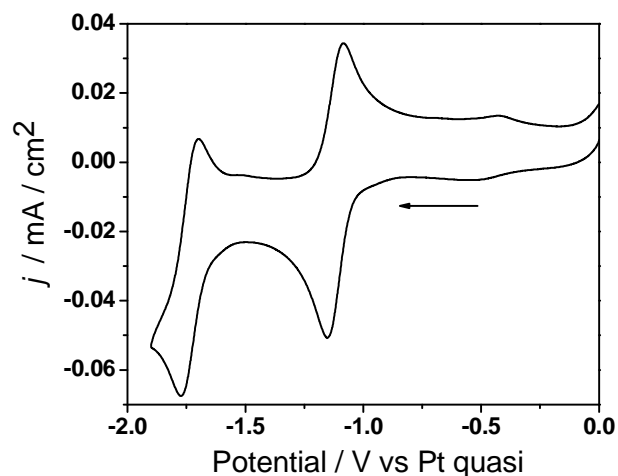


Figure-1 Cyclic voltammogram representing the electrochemical reduction of 10 mM n-methyl-4,4'-bipyridinium cation in presence of N₂ in BMP⁺ TFSI⁻ ionic liquid on glassy carbon electrode.

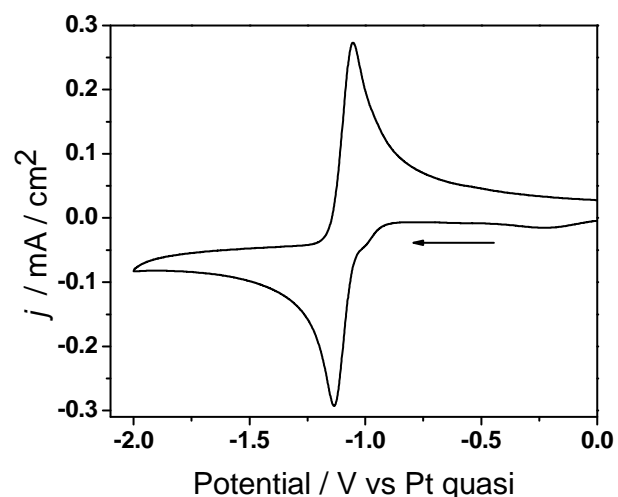


Figure-2 Cyclic voltammogram showing the electrochemical reduction of 10 mM n-methyl-4,4'-bipyridinium cation in presence of CO₂ in BMP⁺ TFSI⁻ ionic liquid on glassy carbon electrode.

References

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