The Role of Ionic Liquids in the Enhancement of Electrocatalytic CO_2 Reduction Processes

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Ionic liquids (ILs) are unique solvents that are emerging as superior alternatives to organic solvents for many applications, including electrocatalysis. We recently demonstrated a new strategy for significantly improving the efficiency of electrocatalytic CO_2 reduction with a homogeneous catalyst, using an IL as both the solvent and electrolyte.[1] With 1-ethyl-3-methylimidazolium tetracyanoborate ([emim][TCB]) as the IL and *fac*-ReCl(bpy)$(CO)_3$ as the catalyst, the onset potential for the catalytic reduction of CO_2 to CO shifts positive by ~0.45 V compared to when acetonitrile solvent is used in the presence of a conventional electrolyte ($[Bu_4N][PF_6]$). Furthermore, the apparent CO_2 reduction rate constant, k_{app}, in [emim][TCB] exceeds that in acetonitrile by over one order of magnitude (k_{app} = 4000 vs 100 M^{-1} s^{-1}) at 25 ± 3 °C. In more recent work,[2] we investigated the thermodynamic parameters for CO_2 reduction in the presence of an IL, and also examined the role of the IL in the observed catalytic enhancement, which revealed the bifunctionality of imidazolium cations for homogeneous electrochemical CO_2 reduction, i.e., as proton donors and catalytic promoters.

References

[1] D. C. Grills, Y. Matsubara, Y. Kuwahara, S. R. Golisz, D. A. Kurtz, B. A. Mello, *J. Phys. Chem. Lett.* **2014**, *5*, 2033-2038.

[2] Y. Matsubara, D. C. Grills, Y. Kuwahara, *ACS Catal.* **2015**, *5*, 6440-6452.