Ionic Liquids: From CO_2 Capture to Electroplating

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Abstract

Ionic liquids (ILs) are organic salts that have sufficiently low melting points that, in their pure state, they are liquid around room temperature. Typical compounds are comprised of a quaternary ammonium, quaternary phosphonium, imidazolium or pyridinium cation with a wide variety of common anions. Since they are salts they have negligible vapor pressure so they do not evaporate and cause air pollution. We will discuss typical properties of ILs and, more importantly, how those properties can be tuned by the choice of cation, anion and substituents. Our emphasis is on the development of ILs for a variety of important applications, many of which are energy-related. In particular, we will discuss work on the design of ILs for gas separations, including removal of CO_2 from post-combustion flue gas, pre-combustion gases, and natural gas. In some of these applications it is necessary to increase capacity and selectivity by including amine functionality in the ILs so that they can chemically react with CO_2. We show how the use of amine functionalized aprotic heterocyclic anions can achieve 1:1 uptake with tunable reaction enthalpy and without increases in viscosity. We will also discuss the use of ILs for CO_2/IL co-fluid vapor compression refrigeration. This system offers environmental advantages over conventional technology while improving coefficients of performance. Finally, we will show how the structure of the anion and cation can improve the 'ionicity' of ILs. This is important in the use of ILs as electrolytes for a wide variety of electrochemical applications, including lithium-ion batteries, dye sensitized solar cells, supercapacitors and electroplating.