From Low Temperatures to High: Systematic Manipulation of Ion Structures to Achieve Low Melting Points and High Decomposition Temperatures

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Our group is keenly interested in probing and learning to systematically manipulate the relationship between the structure of IL ions and their thermal properties - both their melting points and their decomposition temperatures. We have discovered that, by-in-large, the structural characteristics that give rise to low melting points are often inconsistent with achieving truly high degrees of high-T stability (i.e., stability to T > 250 for months). This has resulted in our efforts being bifurcated into parallel projects in which the objective of one is the achievement of low T_m values with retention of moderate thermal stabilities, while the objective of the other is the achievement of very high thermal stabilities in conjunction with workably low values of T_m. In the former case, we have made considerable progress in achieving low T_m values in relatively large-ion ILs by building on the biological principle of the homeoviscous adaptation of cell membranes. Specifically, we found the incorporation of alkene-groups in IL cation side chains predictably results in lower values of T_m relative to counterparts with saturated side chains. Most recently, we have found that this effect is also imparted to ILs by the incorporation of thioether groups into ion side chains. In terms of ILs stable to high temperatures, we have found that there appears to be a quite limited scope of structural and compositional elements consistent with the creation of molecular cations with high long-term thermal stability. In this talk we will discuss in detail what these elements are, as well as discuss why this is the case. Overall, we will endeavor to provide a conceptual toolkit which others may find useful in making informed choices of ion design to create ILs with particular thermal characteristics.