Electrotunable Lubricity with Ionic Liquid Nanoscale Films

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Friction and adhesion forces between solid surfaces mediated by nanometer thin liquid films of ionic liquids, depend strongly on the structure of the liquid. Ionic liquids (IL) are a particularly attractive kind of fluids, with considerable physical and technological interest. The interfacial structure of ionic liquids can be modified considerably by charging the confining surfaces. The surface charges induce layering, with alternating positive and negative ion layers that extend several molecular diameters into the bulk. The structuring of the liquid can play a key role in defining the lubrication properties of the film. Using non-equilibrium molecular dynamics simulations and a coarse grained model of ionic liquid, we carry out an extensive investigation of the structural and dynamic properties of room temperature ionic liquids (RTILs) and theirs prospect as lubricants for friction applications when the liquids are confined between charged surfaces. We elucidate the connection between surface charge density, liquid layering, and lubrication. We identify two mechanisms that control the dependence of the friction force with the surface charge density, namely, (i) the in-plane ordering of the film, and (ii) the swapping of anion and cation layers at the charged surfaces. We also address how water adsorption influences the structure of the ionic liquid and the lubricating properties in nanoscale films, and compare our results with recent AFM measurements. Our results open a route to the *in situ* control of friction without changing the chemical composition of the lubricant.