After several decades of intense research, room temperature chloroaluminate ionic liquids can now be considered a viable alternative to organic solvent-based alkyl-aluminum electrolytes for the commercial electroplating of aluminum. While their possible use also includes electrochemical energy storage in secondary batteries, the development of chloroaluminate ionic liquid electrolytes was initially aimed at surface finishing, mainly for corrosion protection of steel. The properties of various combinations of Lewis acidic aluminum halogenides and Lewis basic organic halogenide salts have been established in numerous studies and the reaction mechanism of aluminum electrodeposition and dissolution has been explored, also by modeling.