Monoenergetic, high-brightness ion sources such as liquid metal ion sources (LMIS) have become a standard technology in diverse applications ranging from surface analysis and microscopy to lithography and micro/nano manufacturing. A new source with these characteristics can be constructed using an arrangement similar to LMIS but substituting the (heated) liquid metal by a molten salt. This is particularly attractive when the salt is what is known as an ionic liquid, or room-temperature molten salt. These compounds are poorly coordinated mixtures of organic cations and (typically) inorganic anions and have melting points that in some cases are well below 0°C. Ionic liquids are thermally stable over a wide temperature range; they do not boil, but decompose at temperatures typically higher than 250 °C. The extremely reduced vapor pressure of most ionic liquids allows them to be used in high-vacuum conditions without noticeable outgassing. These liquids show an appreciable electrical conductivity and are therefore subject, just as liquid metals are, to electrostatic deformation with the difference that their surface tension is about an order of magnitude lower than most liquid metals. This means that the electrohydrodynamic instability that enhances the electric field to produce ion evaporation from a nano-meter sized region in the liquid meniscus can be created with significantly lower voltages.

Ion beams produced by these ionic liquid ion sources (ILIS) have energy deficits and distributions that closely resemble their metallic counterparts, with the exception that they can be stably operated at current levels as low as a few nA if needed. These very low currents are beneficial in reducing aberrations in focused ion beam (FIB) columns. There are two important characteristics of ILIS that make the technology unique. First, since the liquid is exclusively formed by positive and negative ions, it is possible to change the polarity of the ion beam simply by reversing the power supply. Second, the number of available ionic liquids is extraordinarily large. This means that ILIS can produce very diverse molecular ions in terms of their masses, composition and properties. We are particularly interested in the benefits that ILIS technology would bring as a compact source of high-brightness negative ions, which have the potential to reduce considerably the charge build-up that limits the ability to focus non-neutralized ion beams on electrically floating or dielectric substrates. In addition, some of the negative ions in ILIS are reactive species that could be used for enhancing etching rates in several applications without recurring to chemical assistance.

In this paper we present an overview of ILIS sources and we show some preliminary results of their performance in a FIB column. We also discuss how are they implemented, their limitations and prospective applications.