

Review: Ionic Liquid Crystal

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Abstract: This Review discusses current advancements in thermotropic ionic liquid crystal design, synthesis, characterization, and application from 2005 to 2015. It was created to provide a thorough review of the "state-of-the-art" in the industry. Low molar mass and dendrimeric thermotropic ionic mesogens, as well as a few metal-containing compounds are the main topics of study. However, there will also be some references to lyotropic or polymeric ionic liquid crystals, and more specifically, to ionic liquids. The focus will be on liquid-crystalline materials made up of organic cations and inorganic/organic anions that are not covalently bonded but interact via electrostatic and other noncovalent interactions, but mesoionic and zwitterionic mesogens are also discussed to some extent.

Keywords: Ionic liquid crystal, historical background, applications

INTRODUCTION

Ionic liquid crystals (ILCs) are intriguing liquid-crystalline solids made up entirely of cations and anions. Despite the fact that the first ILCs were reported in 1938. Thermotropic ILCs combine the traits of liquid crystals (dynamic molecular order and self-assembling ability, anisotropic physical properties, and so on) with those of ionic liquids (ionic conductivity, "tuning" possibilities, and so on) (Binnemans, 2005). While the majority of liquid crystals (LCs) are neutral organic molecules, there are also many ionic liquid crystals (ILCs). Mesogens are substances that contain (positively charged) cations and (negatively charged) anions. ILC characteristics may differ dramatically from those of ordinary LCs due to their ionic character. ILCs are normally fabricated by organic nitrogen cations moiety, like imidazolium (Bowlas 1996), pyridinium (Nusselder, 1993, Ujiie, 2005) bipyridinium (Causin, 2009, Casella, 2014, Casella, 2016, Asaftei, 2012) guanidinium (Butschies, 2010, Sauer, 2009) pyrrolidinium (Tao, 2012) to mention the most common ones, and inorganic anions moiety like halides, tetrafluoroborate, hexafluorophosphate, bis (trifluoromethanesulfonyl) imide (also known as bistriflimide, or Tf_2N^-). Gordon et. al. investigated at temperatures above their melting point, a set of new hexafluorophosphate salts based on N,N'-dialkylimidazolium and substituted N-alkylpyridinium cations exhibit liquid crystalline behaviour. With increasing alkyl chain length, the temperature range at which liquid crystalline behaviour is observed expands significantly. Alkyl substitution at the 3- and 4-positions on the pyridinium ring lowers the melting point relative to the equivalent unsubstituted salt, but also reduces the tendency to liquid crystalline behaviour significantly (or mesogenicity). In the instance of 1-dodecyl-3-methylimidazolium hexafluorophosphate, the salts are fully described using a wide range of techniques, including NMR and IR spectroscopy, DSC, and single crystal X-ray diffraction. The effect of producing mixes with varying quantities of two cations is also discussed (Gordon, 1998). Yamanaka et. al. used of a new ionic liquid crystal, 1-dodecyl-3-methylimidazolium iodide, and iodine as an electrolyte of dye-sensitized solar cells results in a high short

circuit photocurrent density and a high light-to-electricity conversion efficiency due to a self-assembled structure of the imidazolium cations, resulting in high conductivity of the electrolyte reported (Yamanaka, 2005). Lin et. al. studied ionic liquids and ionic liquid crystals of imidazolium salts made of several transition and main group metals. Ionic metal complexes of imidazoles and N-heterocyclic carbenes with similar characteristics were also included. These ILs and ILCs have been identified as possible solvents, catalysts, catalyst precursors, and reagents for numerous chemical transformations, as well as ecofriendly methods. They've also been discovered to perform important roles in material science. Many of these IL systems are air- and moisture-stable and are being evaluated as alternatives to air- and moisture-sensitive chloroaluminate-based ILs (Lin, 2005). Chiou et. al. worked on the N-alkyl chain of imidazolium ionic liquid crystals, a 2-hydroxyl pendant group. When compared to those lacking the hydroxyl group, this hydroxyl group boosted hydrogen bonding connections between nearby molecules, hence broadening the temperature range of the mesophase. Many ionic liquid crystals formed at ambient temperature. The characteristics of these materials were investigated using polarised optical microscopy, differential scanning calorimetry, X-ray diffraction, and infrared spectroscopy. To have a better understanding of the structure relationship between the solid and liquid crystals, the molecular structure of one of the compounds was determined using single crystal X-ray diffraction (Chiou, 2006). Kouwer et. al. ionic liquid crystals combine the unique solvent properties of ionic liquids with liquid crystal self-organization. We present a thorough examination of the structure-property relationship of a new class of imidazolium-based liquid crystals with an extended aromatic core. The length and character of the tails, the length of the stiff core, the lateral substitution pattern, and the nature of the counterion are all investigated parameters. Two mesophases were detected, depending on the molecular structure: a bilayered SmA2 phase and the more frequent monolayered SmA phase, both of which were heavily interdigitated. Most materials exhibit mesophases that are stable to high

temperatures. Crystallization could be suppressed in some situations, resulting in room-temperature liquid crystalline phases (Kouwer, 2007).

This Review focuses on current advances in the design, synthesis, characterisation, and use of ionic liquid crystals. It was intended to provide a thorough overview of the "state-of-the-art" in the sector.

CONCLUSION

The combination of all of these options with the potential to tune the cationic and anionic components' quasi-independent choice to affect the mesomorphic behaviour, phase transition temperatures, and other features ("tunability") demonstrates the ILCs' genuine adaptability. ILC commercial application development is still far behind mesomorphic structure design in terms of development. This is a normal procedure and it is not surprising. However, ILCs used in industrial settings may provide this study area a significant boost. This has been seen in the past with LCs and ILs. Despite these drawbacks, we fervently think that the study area of ILCs has a highly promising future because it is thriving, continually expanding, and diversified.

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