New and Improved Materials for Energy Applications Enabled by Ionic Liquids and Deep Eutectics

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Nanomaterials have become indispensable for modern life. Many technologies depend critically on nanomaterials with engineered properties and structures, particularly those related to clean energy applications such as photocatalysts, light phosphors, thermoelectrics and others. Technological borders could be pushed further and improved materials would become available if more powerful tools for the tailored synthesis of nanomaterials could become available. In this, ionic liquids (ILs, room temperature molten salts) and deep eutectic solvents (DES) have the potential to become a true game changer. These unconventional solvents are permitting more efficient, safer and environmentally benign preparation of high quality products.

ILs, which can be built by a wide variety of cation-anion combinations with different functionalities, can act as the reaction medium, particle stabilizing and templating agent all-in-one, sometimes even as the reaction partner. IL based nanomaterial synthesis is faster, safer, and more energy- and atom-efficient than comparable methods. It uses less toxic chemicals, omits the use of auxiliary substances such as stabilizers, and minimizes waste. Through coupling with unconventional synthetic routes (physical vapor deposition, microwaves, ultrasound) that take advantage of their unique properties, ILs become even more powerful in nanomaterials synthesis.

Mixed systems such as DES offer a similarly broad combinatorial playground, which is also beginning to translate into applications. Approached holistically, these liquids therefore enable new universal manufacturing techniques that provide solutions to the existing problems of nanomanufacturing, and beyond that will open completely new horizons and possibilities for controlling the growth and assembly of nanostructures.

Examples that illustrate the power of ILs and DES in the improved manufacturing of nanomaterials are explored, such as the synthesis of light phosphors with exceptional quantum yields, record-figure-of merit thermoelectrics, and efficient photocatalysts.

References

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