

Ionic Liquids: Classification, Synthesis and Application

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Volatile Organic Compounds (VOCs)

❖ VOCs have high vapour pressure

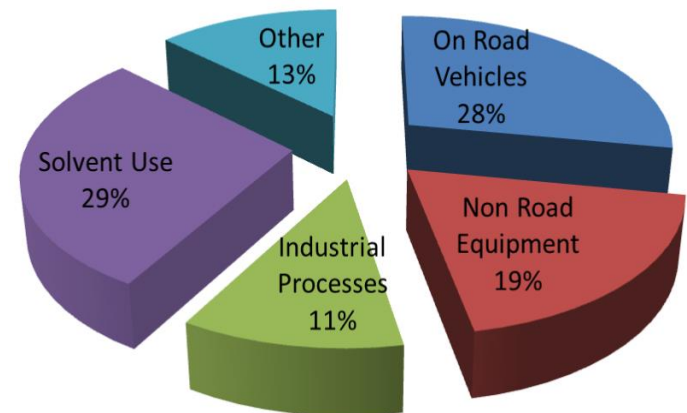
❖ Drawbacks of VOCs

- **air pollution**
- **ozone depletion**
- **global warming**
- **climatic changes**
- **human health-related problems.**



❖ VOCs are mainly used as solvents that play a crucial role in many areas of technology

Solvent Name	Boiling Point/°C
Acetone	56
Benzene	80
Chloroform	61
Diethyl ether	35
Ethanol	78
Dichloromethane	40
Hexane	69



Sources of VOCs

Best Approaches to Solvent Replacement

- ❖ No solvent
- ❖ Water
- ❖ Supercritical fluids
- ❖ **Green Solvents**

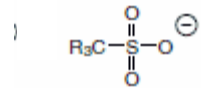
Ionic Liquids and Deep Eutectic Solvents are the two examples of Green solvents

All have their own advantages and disadvantages

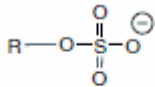


Ionic Liquids (ILs)

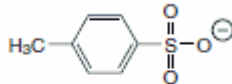
Organic anions



methanesulfonate



alkylsulfate



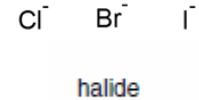
tosylate

❖ Salts composed of cations and anions.

❖ Generally, they are liquid at room temperature

cation anion

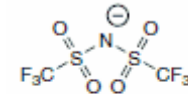
Inorganic anions



tetrafluoro-
borate

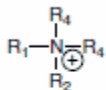


hexafluoro-
phosphate

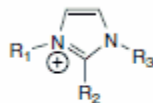


bis(trifluoromethyl-
sulfonyl)imide

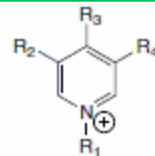
Millions of ionic liquids possible



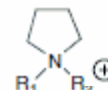
ammonium



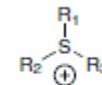
imidazolium



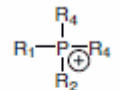
pyridinium



pyrrolidinium



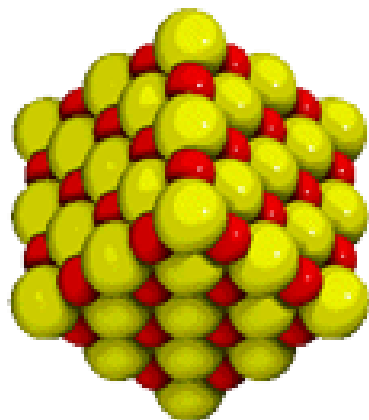
sulfonium



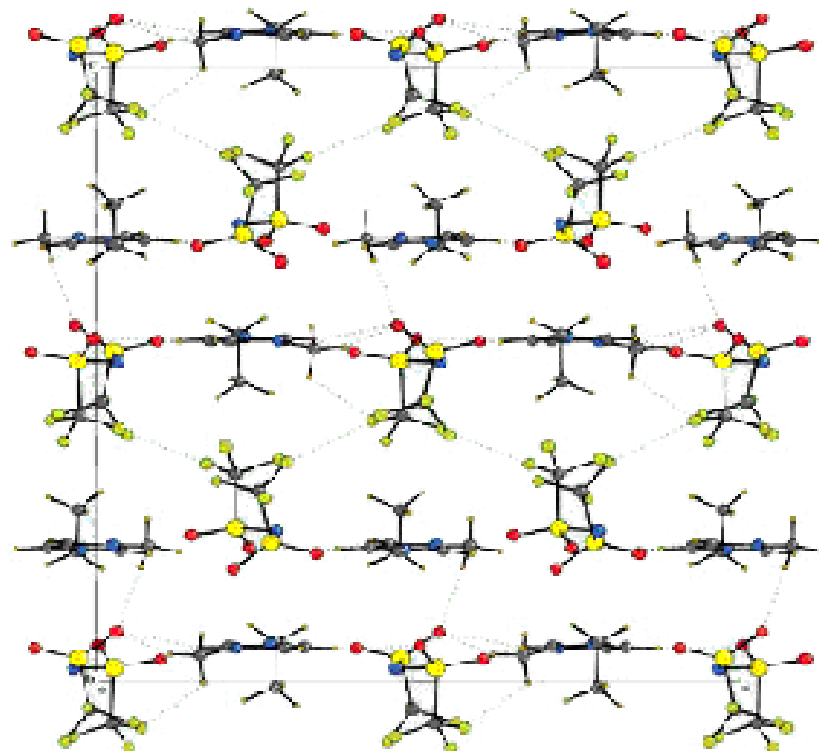
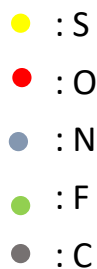
phosphonium

Organic cations

Ionic Salts Vs Ionic Liquids



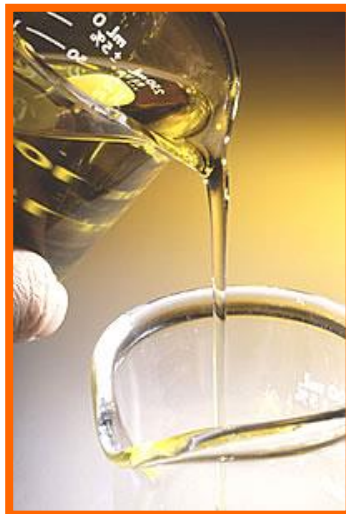
Crystal structure of NaCl



Crystal structure of [EMIM][NTf₂]



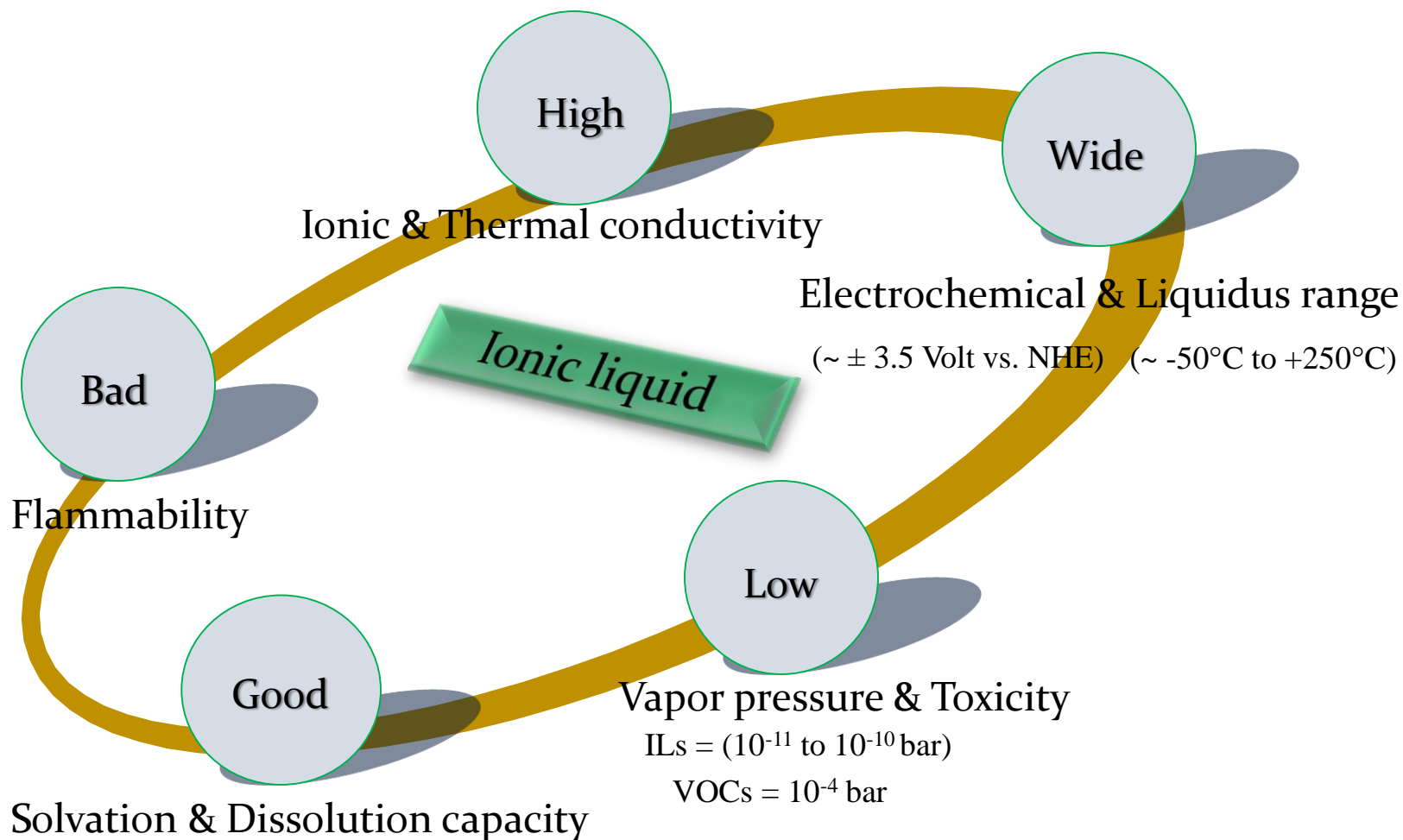
Melting Point = 801 °C



Melting point = -25.7 °C

CrystEngComm, 2006, 8, 742-745.

Characteristic Properties



ILs – Applications

STATUS: ❖ R&D ❖ Pilot ❖ Commercialized

PROCESS TECHNOLOGY

- ❖ Gas-Separation
- ❖ Biomass Conversion
- ❖ Metal-Extraction
- ❖ Liquid-Liquid Extraction

ELECTROCHEMISTRY

- ❖ Fuel Cells
- ❖ Batteries
- ❖ Metal Deposition & Electropolishing
- ❖ DSSCs
- ❖ Electrochromic Windows
- ❖ Sensors
- ❖ Supercapacitors

FUNCTIONAL FLUIDS & ADDITIVES

- ❖ Lubricants
- ❖ Surfactants
- ❖ Hydraulic Fluids
- ❖ Additives

SYNTHESIS & CATALYSIS

- ❖ Enzymatic Reactions
- ❖ Immobilization of Catalysts (SILP)
- ❖ Nanoparticle-Synthesis
- ❖ Organic Synthesis

ANALYTICS

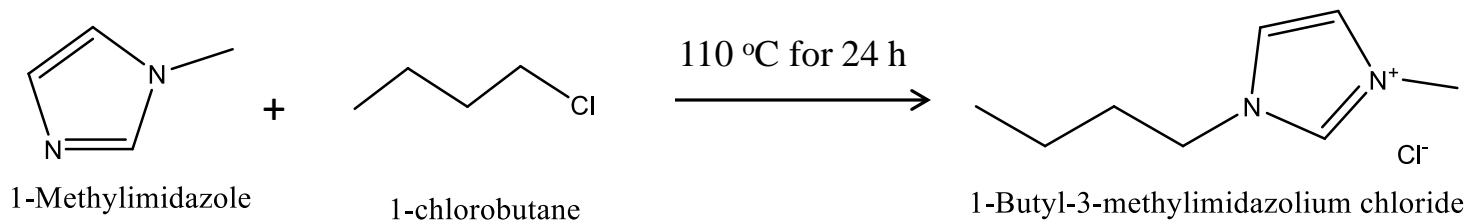
- ❖ Electrophoresis
- ❖ Solvent for GC-Headspace
- ❖ Matrix-Materials for MALDi-TOF-MS
- ❖ Karl-Fischer Titration
- ❖ Protein-Crystallization
- ❖ GC-Materials

HEAT TRANSPORT & CONVERSION

- ❖ Thermal Fluids
- ❖ Phase Changing Materials
- ❖ Sorption Cooling

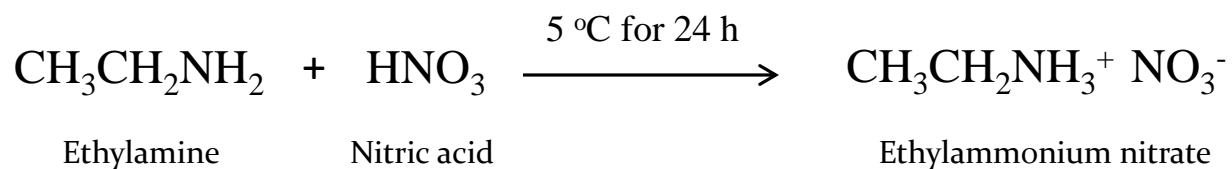


Classification of ILs



Aprotic ionic liquid

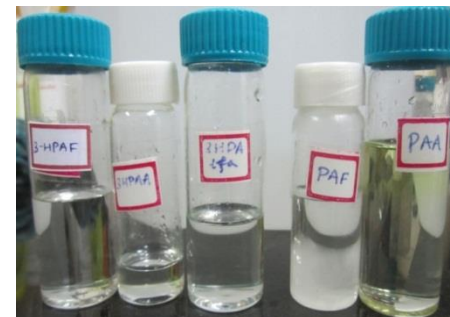
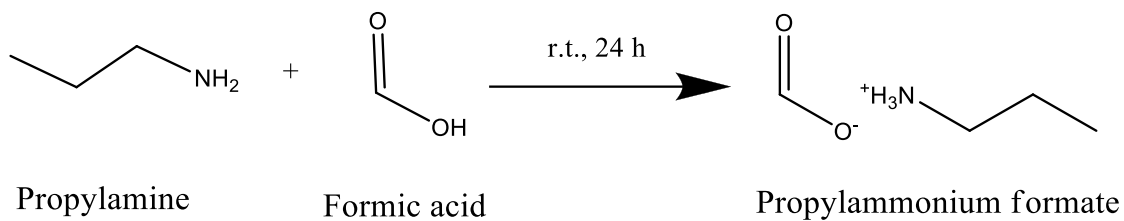
Protic ionic liquid



Synthesis of Protic Ionic Liquids (PILs)

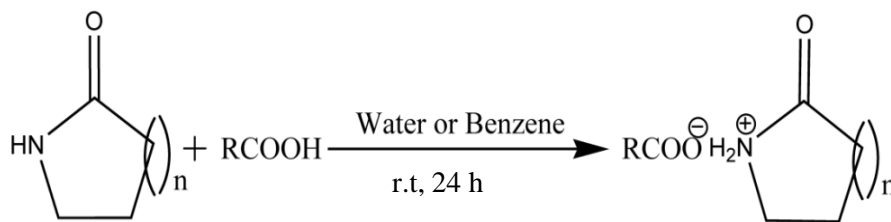
Ammonium ILs

PAF, PAAc, 3HPAF, 3HPAAc, 3HPATFAc



Lactam ILs

BTF, BTAc, BTH, CPF, CPAc, CPH



$n = 1$, Butyrolactam; $n = 3$, Caprolactam; $R = \text{H}, \text{CH}_3, \text{C}_5\text{H}_{11}$



THANK YOU

Any Queries ??...

THANK YOU