

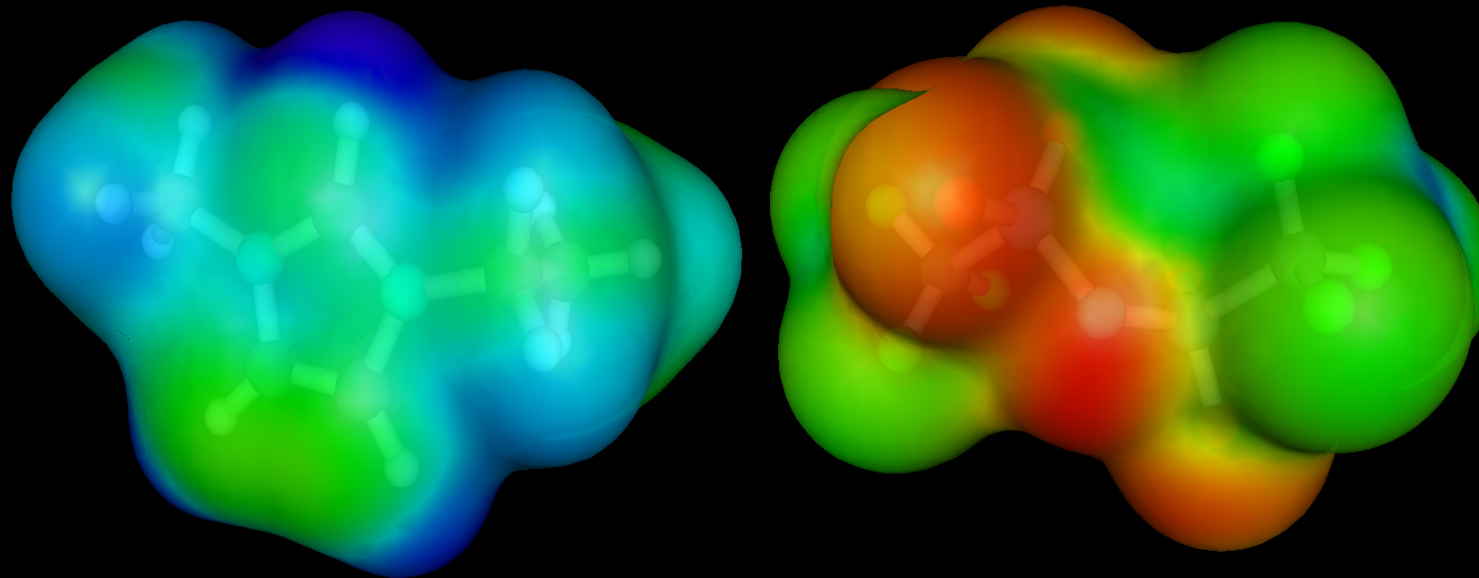


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Anna Świerczyńska,
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D-74076 Heilbronn

- 1 Introduction**
- 2 Solubility Tests**
- 3 Conclusions**
- 4 Company Information**

1 Introduction



1-Ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide

STATUS:





-  R&D
-  Pilot
-  Commercialized

IONIC LIQUIDS PROPERTIES

- Liquid over a Wide T-Range
- Thermal Stability
- Electrochemical Stability
- Low Vapor Pressure
- Non Volatility
- Non Inflammability
- Electric Conducting
- Tunable Miscibility



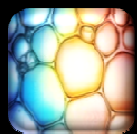
PROCESS TECHNOLOGY

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



FUNCTIONAL FLUIDS & ADDITIVES

-  Hydraulic Oils
-  Additives
-  Lubricants
-  Surfactants






SYNTHESIS & CATALYSIS

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



HEAT TRANSPORT & CONVERSION

-  Thermal Fluids
-  Phase Changing Materials (PCM)
-  Sorption Cooling Media



ANALYTICS

-  Electrophoresis
-  Solvents for GC-Headspace
-  Matrix-Materials for MALDI-TOF-MS
-  Karl-Fischer Titration
-  Protein-Crystallization
-  GC-Materials



ELECTROCHEMISTRY

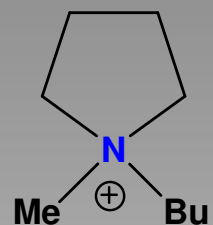
-  Fuel Cells
-  Metal Deposition & Electropolishing
-  Batteries
-  DSSCs
-  Electrochromic Windows
-  Sensors
-  Supercaps



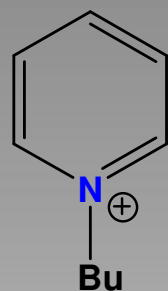
- **Most publications target only a few ILs (in particular BMIM PF₆ and BMIM BF₄) and use specific solvents or solvent mixtures**
- **Recycling of ILs is usually associated with extraction**
- **Process optimization in extraction/separation processes**
- **Production scale-up**
- **Green process evaluation**

A more precise knowledge of the solubility of ILs in common organic solvents is needed to enable more applications in organic synthesis

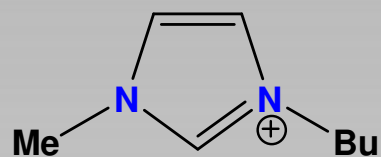
Cations, Anions and Abbreviations



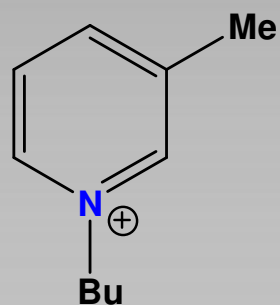
BMPyrr



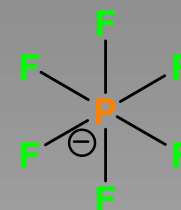
BuPy



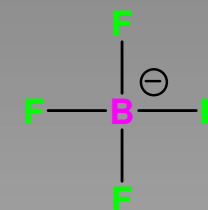
BMIM



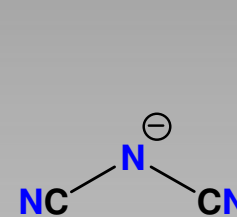
Bu3Pic



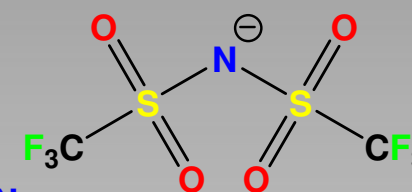
PF₆



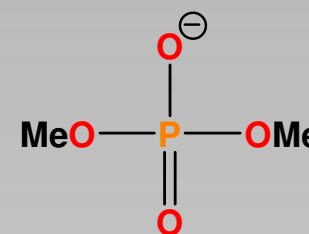
BF₄



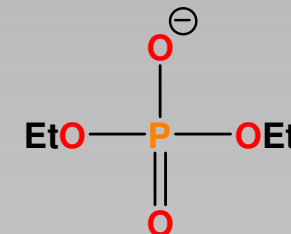
DCA



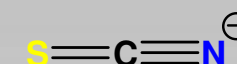
BTA



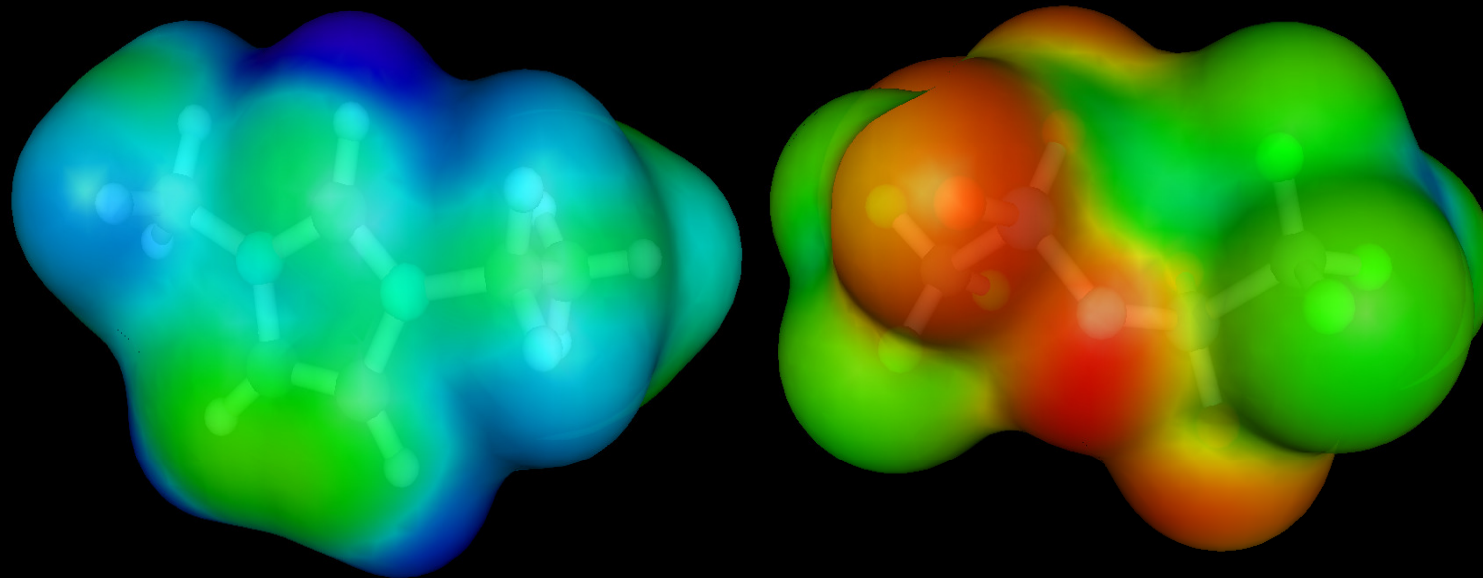
DEP



DMP



2 Solubility Tests



1-Ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide

ILs Used in the Study



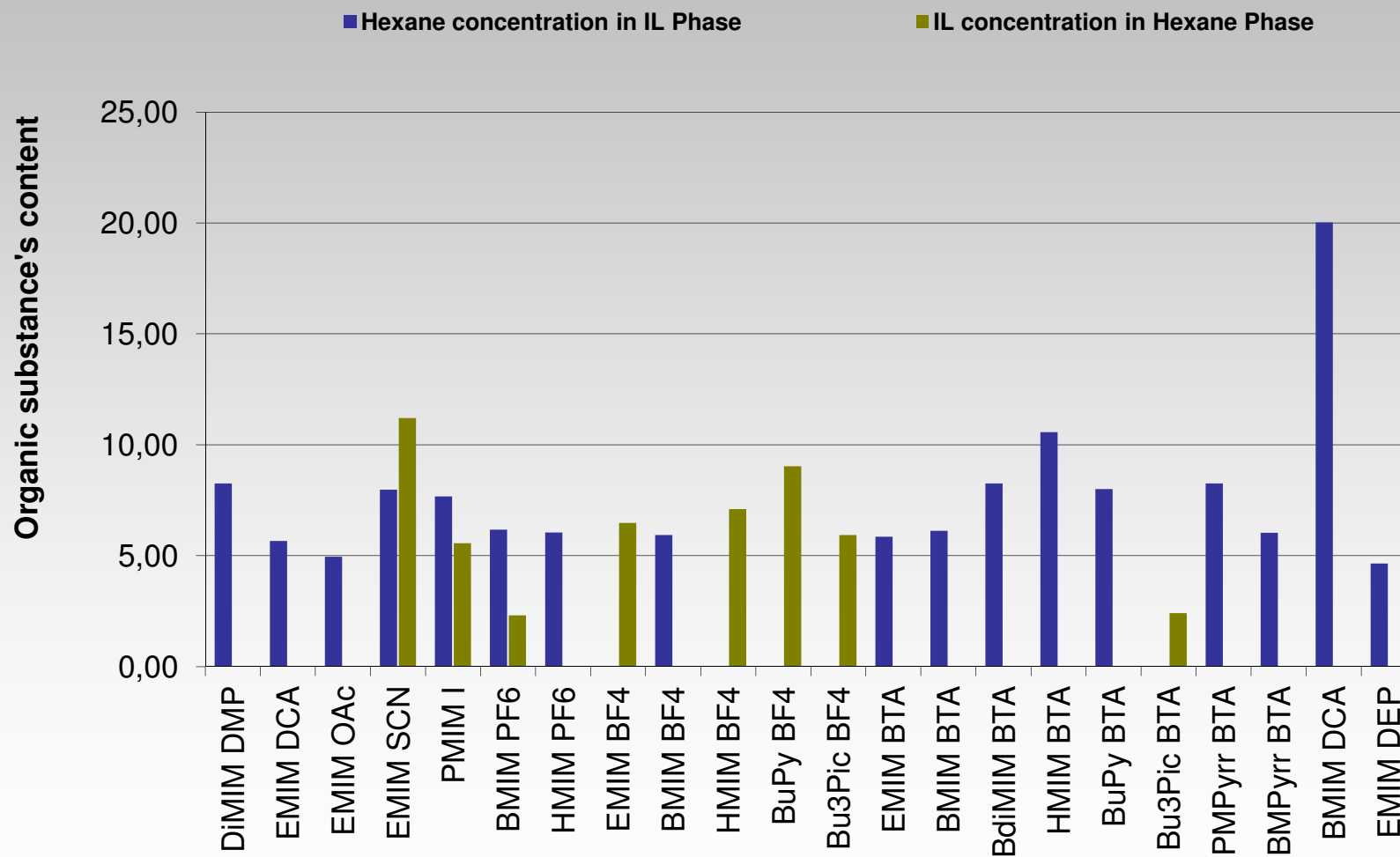
		Acetone	Chloro- form	Ethyl Acetate	Tolu- ene	Hex- ane	Water	THF	Oct- ane	Octa- nol
1	DiMIM DMP	-	+	-	-	-	+	-	-	+
2	EMIM DEP	+	+	-	-	-	+	-	-	+
3	EMIM OAc	+	+	-	-	-	+	-	-	+
4	EMIM SCN	+	+	-	-	-	+	-	-	-
5	PMIM I	+	+	-	-	-	+	-	-	+
6	BMIM PF6	+	+	+	-	-	-	+	-	-
7	HMIM PF6	+	+	+	-	-	-	+	-	-
8	EMIM BF4	+	+	-	-	-	+	-	-	-
9	BMIM BF4	+	+	-	-	-	+	-	-	-
10	HMIM BF4	+	+	+	-	-	-	+	-	+
11	BuPy BF4	+	+	-	-	-	+	-	-	-

ILs Used in the Study (2)

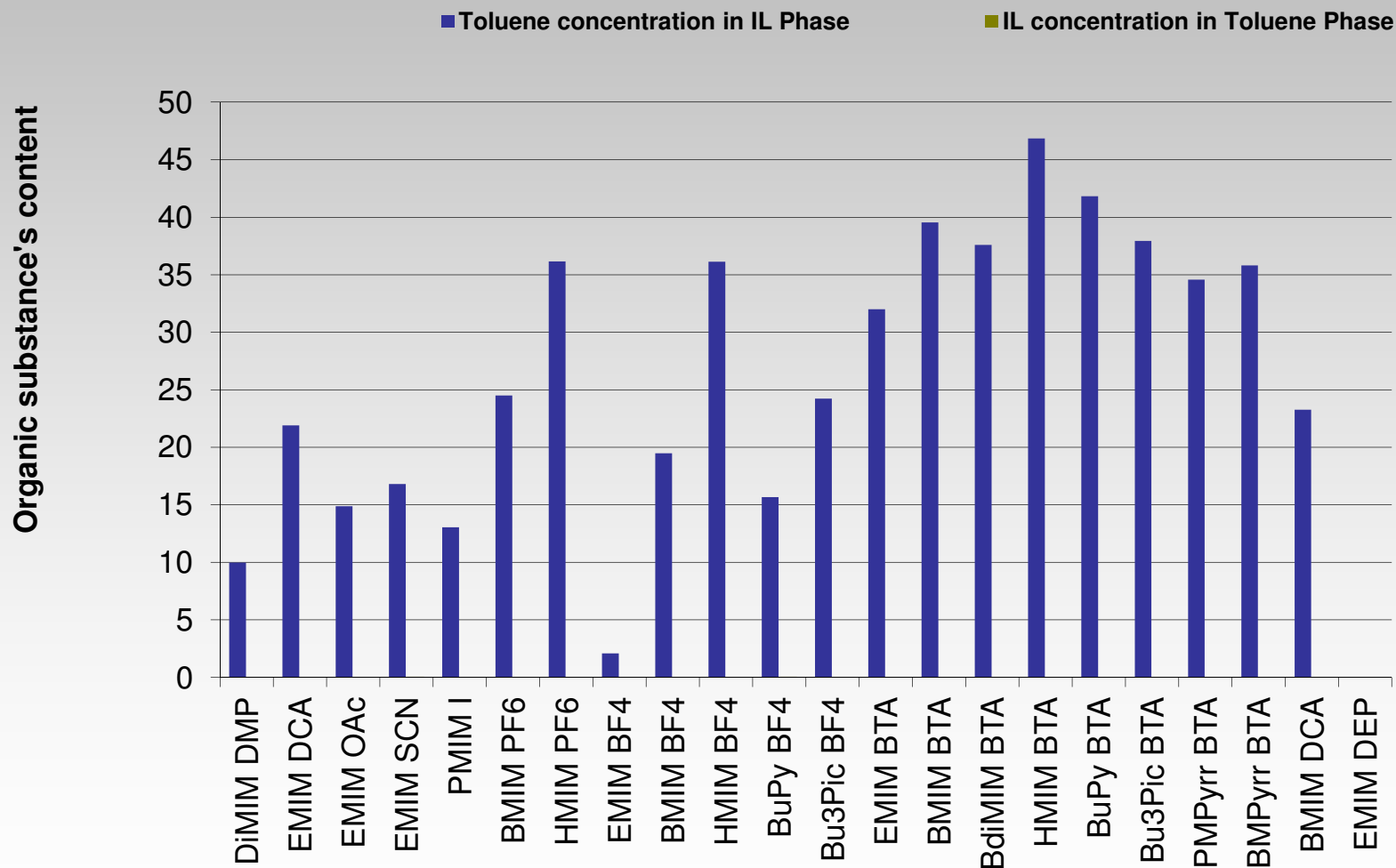


		Acetone	Chloro- form	Ethyl Acetate	Tolu- ene	Hex- ane	Water	THF	Oct- ane	Octa- nol
12	Bu3Pic BF4	+	+	-	-	-	+	-	-	-
13	EMIM BTA	+	+	+	-	-	-	+	-	-
14	BMIM BTA	+	+	+	-	-	-	+	-	-
15	BDiMIM BTA	+	+	+	-	-	-	+	-	-
16	HMIM BTA	+	+	+	-	-	-	+	-	-
17	BuPy BTA	+	+	+	-	-	-	+	-	-
18	Bu3Pic BTA	+	+	+	-	-	-	+	-	-
19	PMPyrr BTA	+	+	+	-	-	-	+	-	-
20	BMPyrr BTA	+	+	+	-	-	-	+	-	-
21	BMIM DCA	+	+	-	-	-	+	+	-	+
22	EMIM DCA	+	+	-	-	-	+	-	-	+

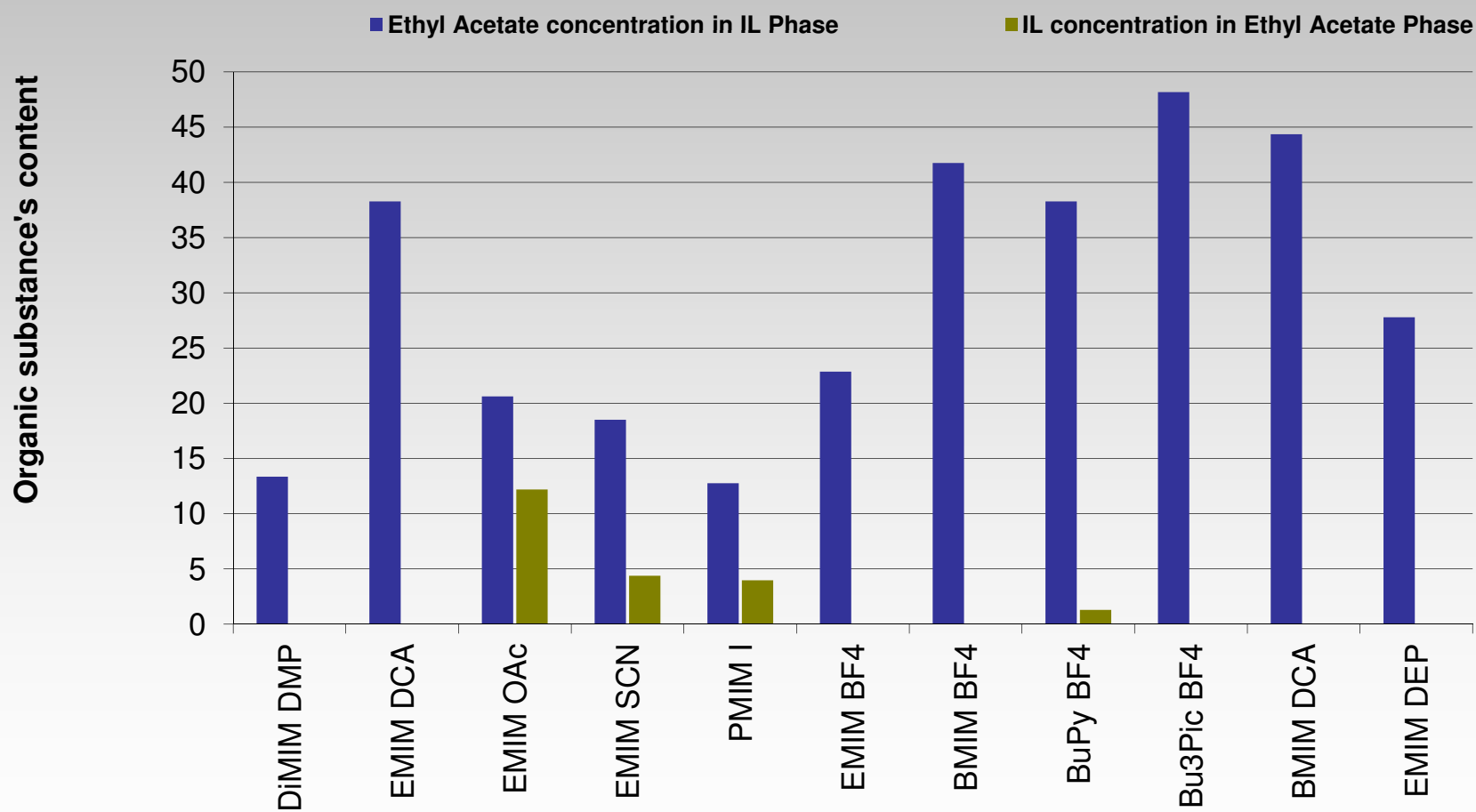
Solubility in Hexane



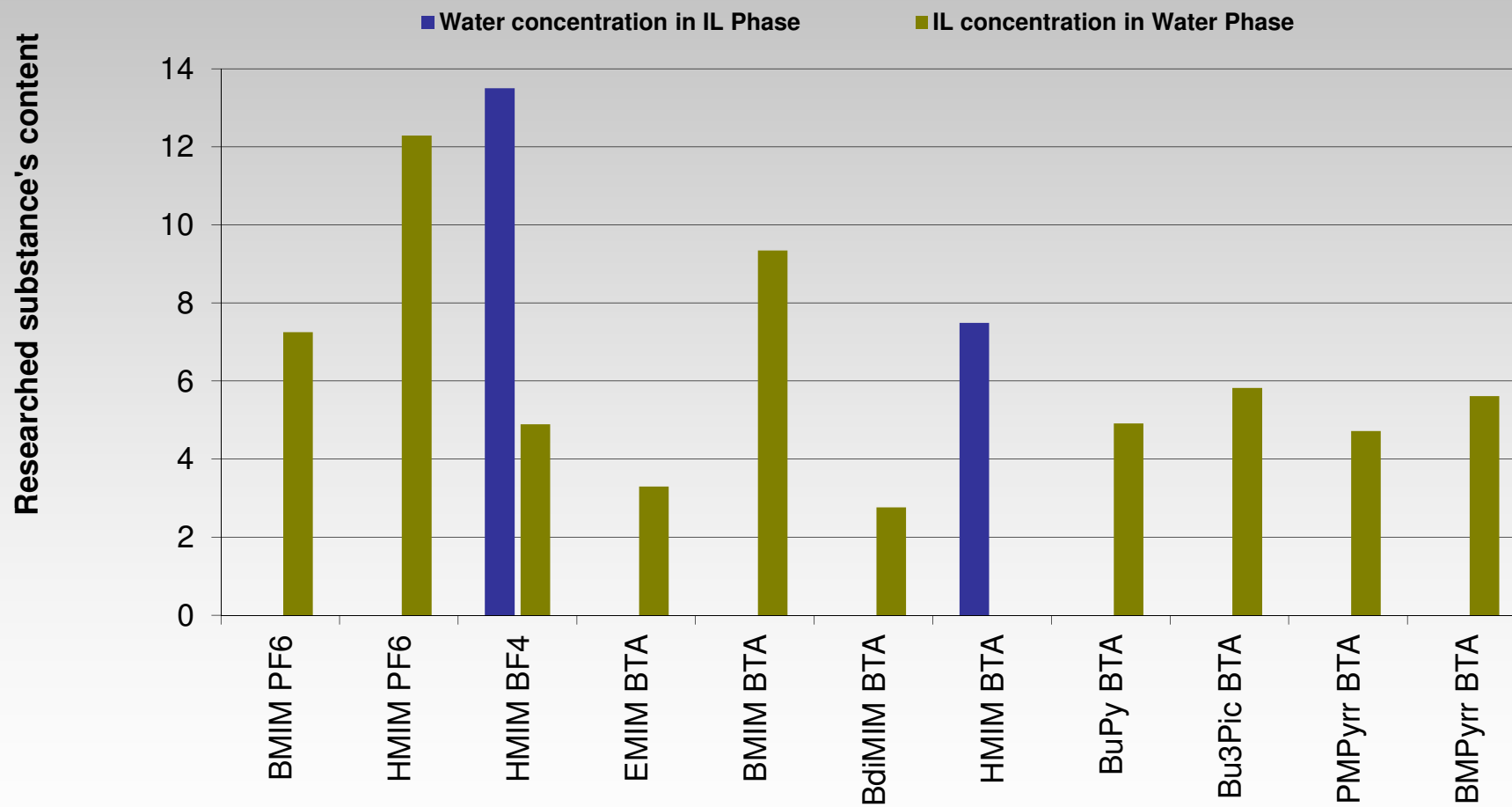
Solubility in Toluene



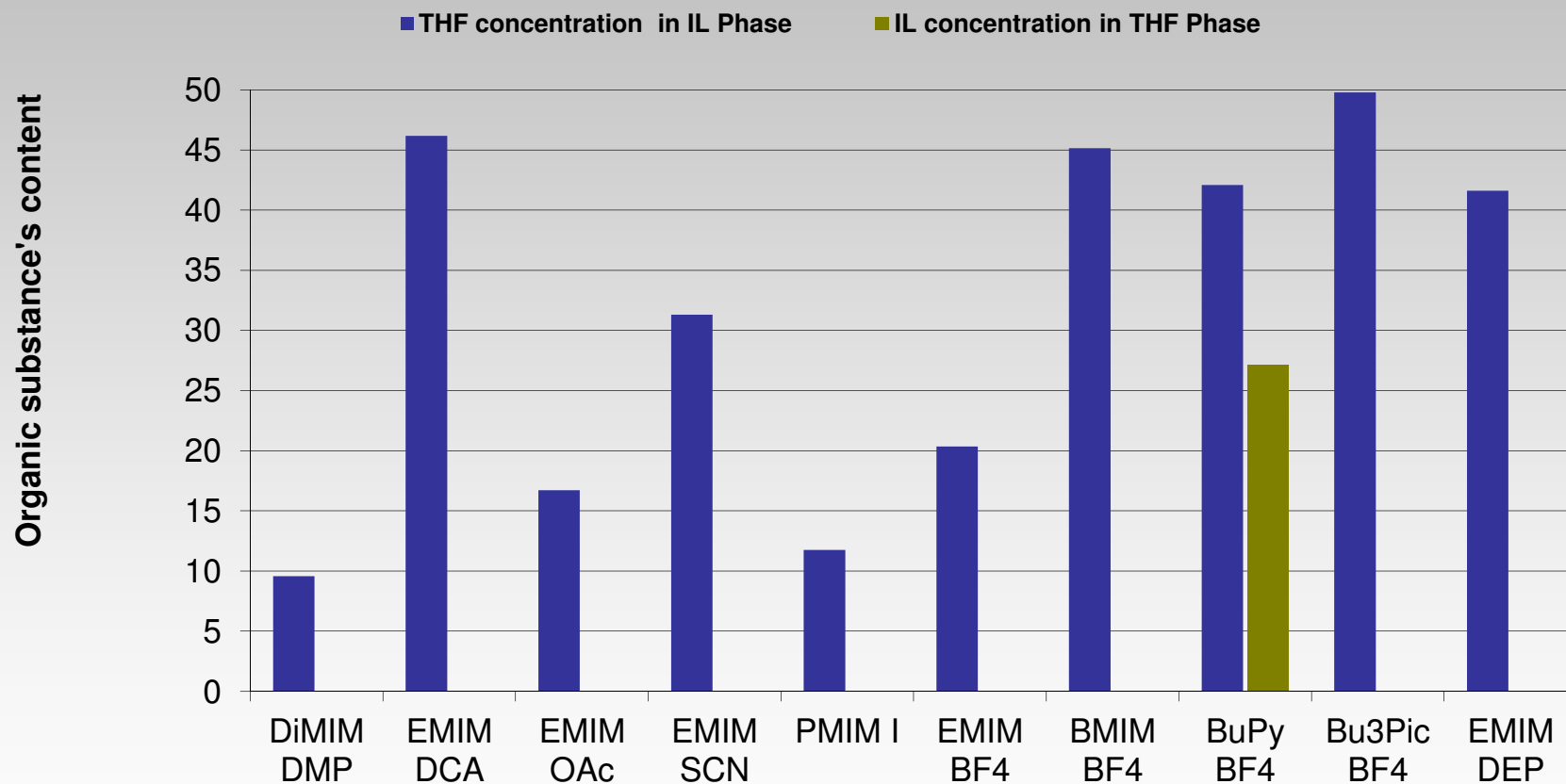
Solubility in Ethyl Acetate



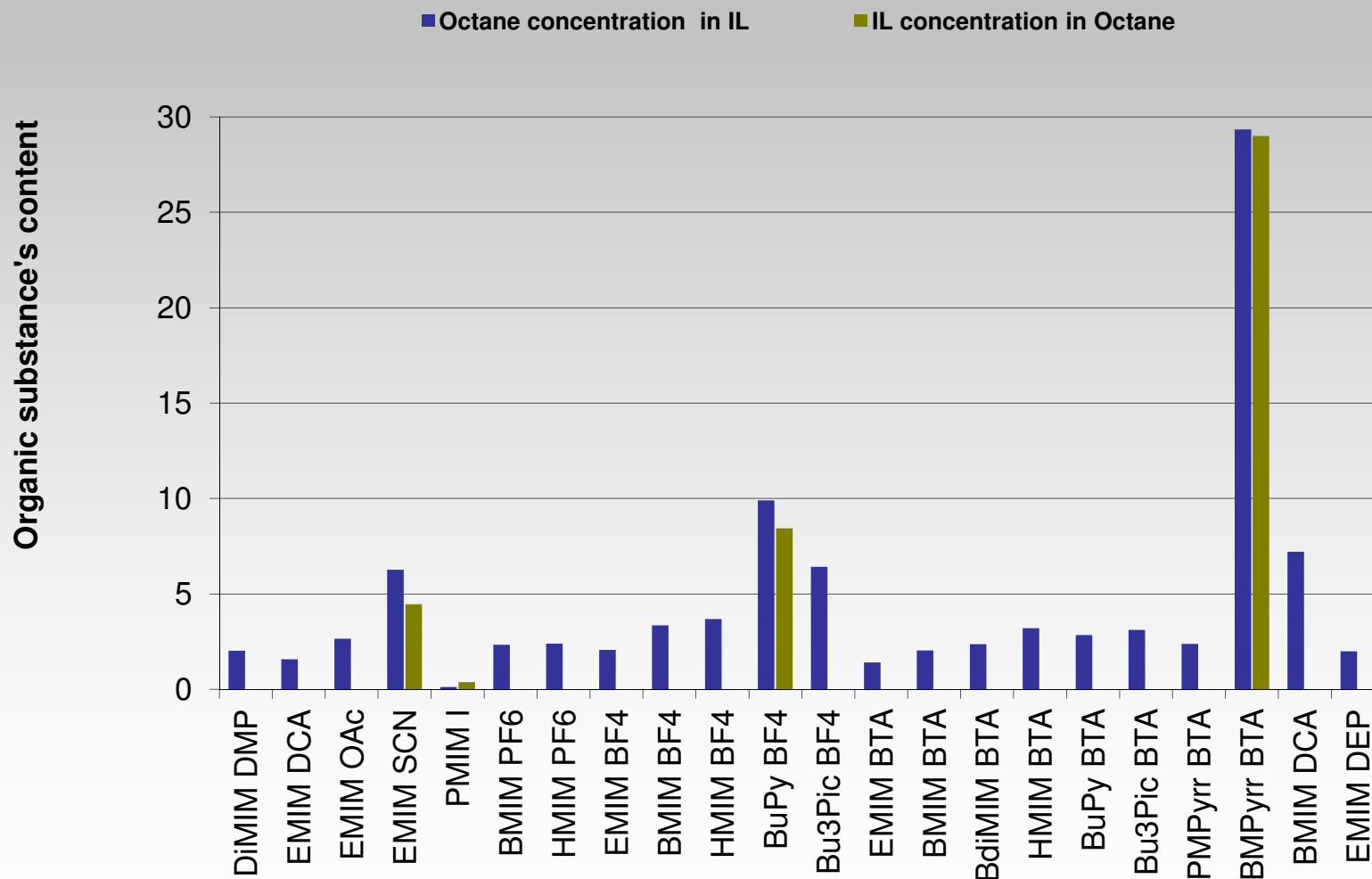
Solubility in Water



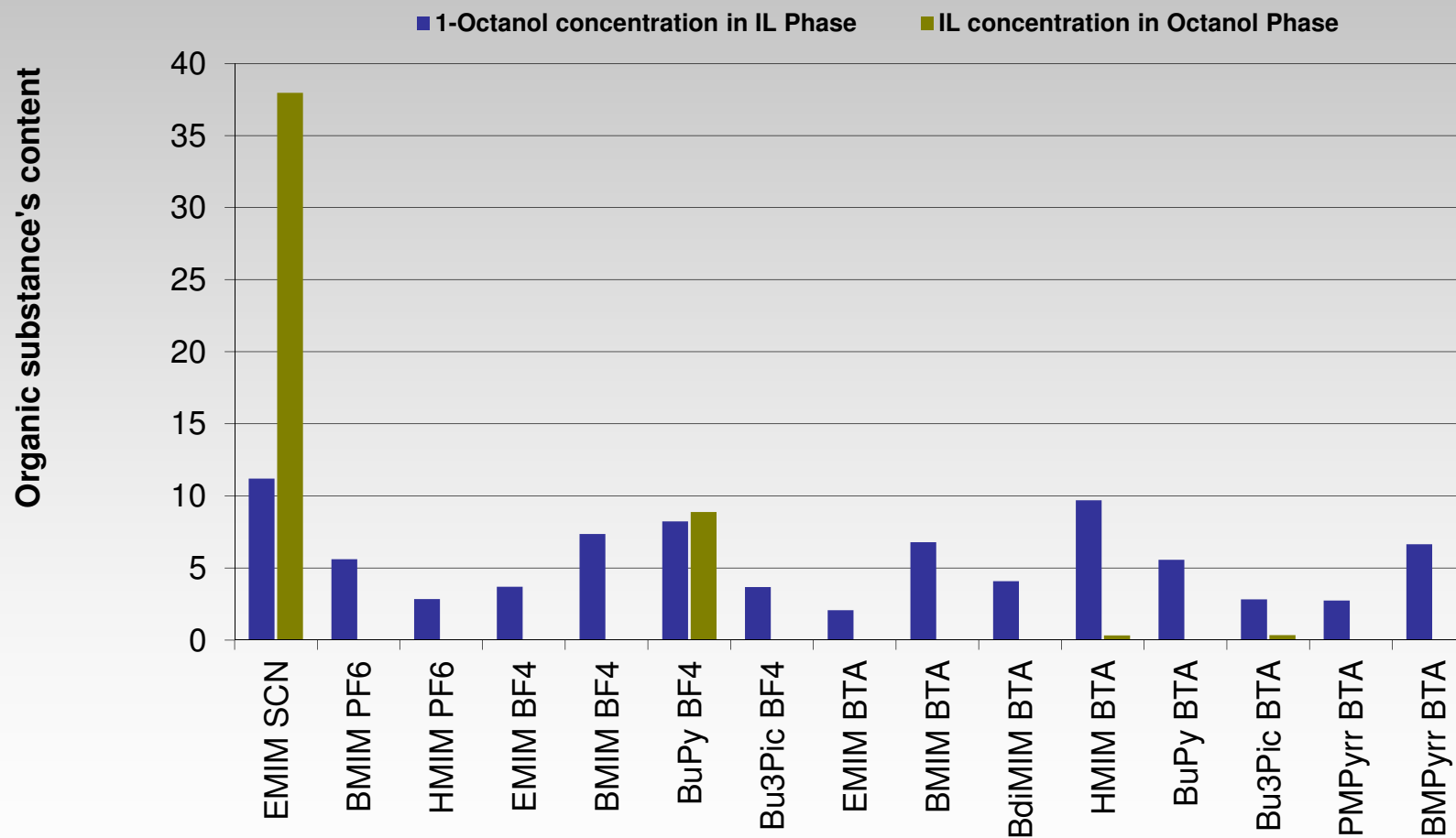
Solubility in THF



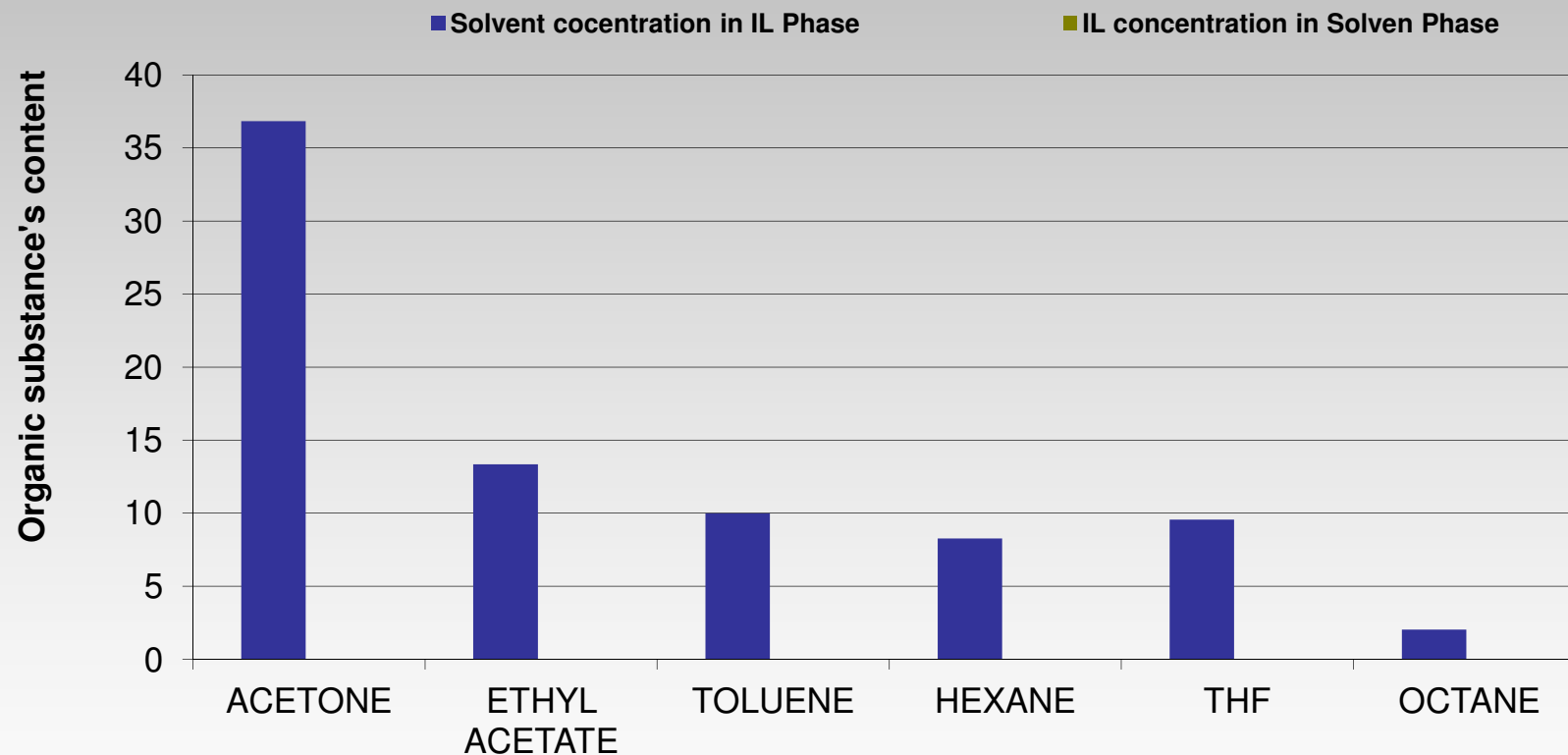
Solubility in Octane



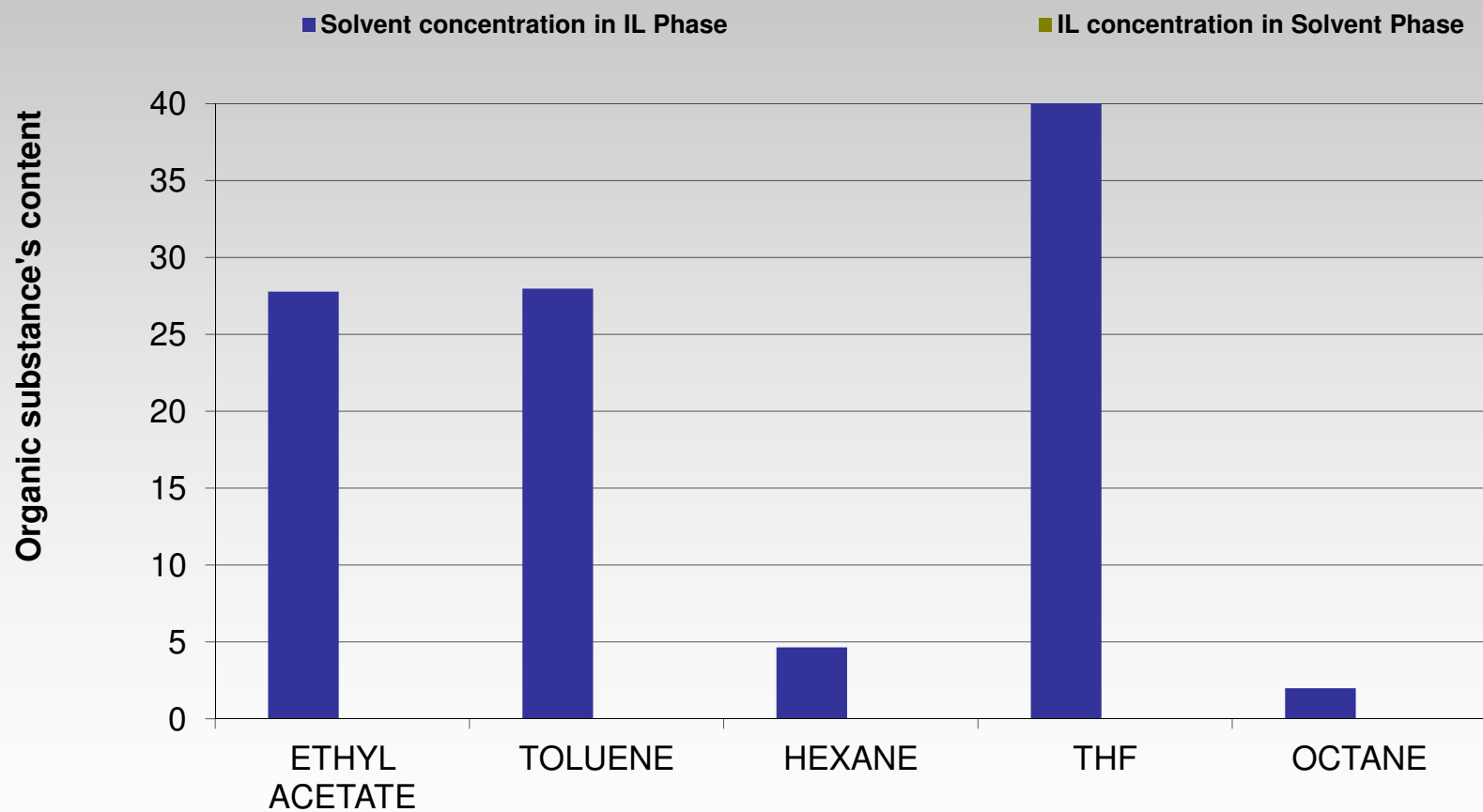
Solubility of 1-Octanol



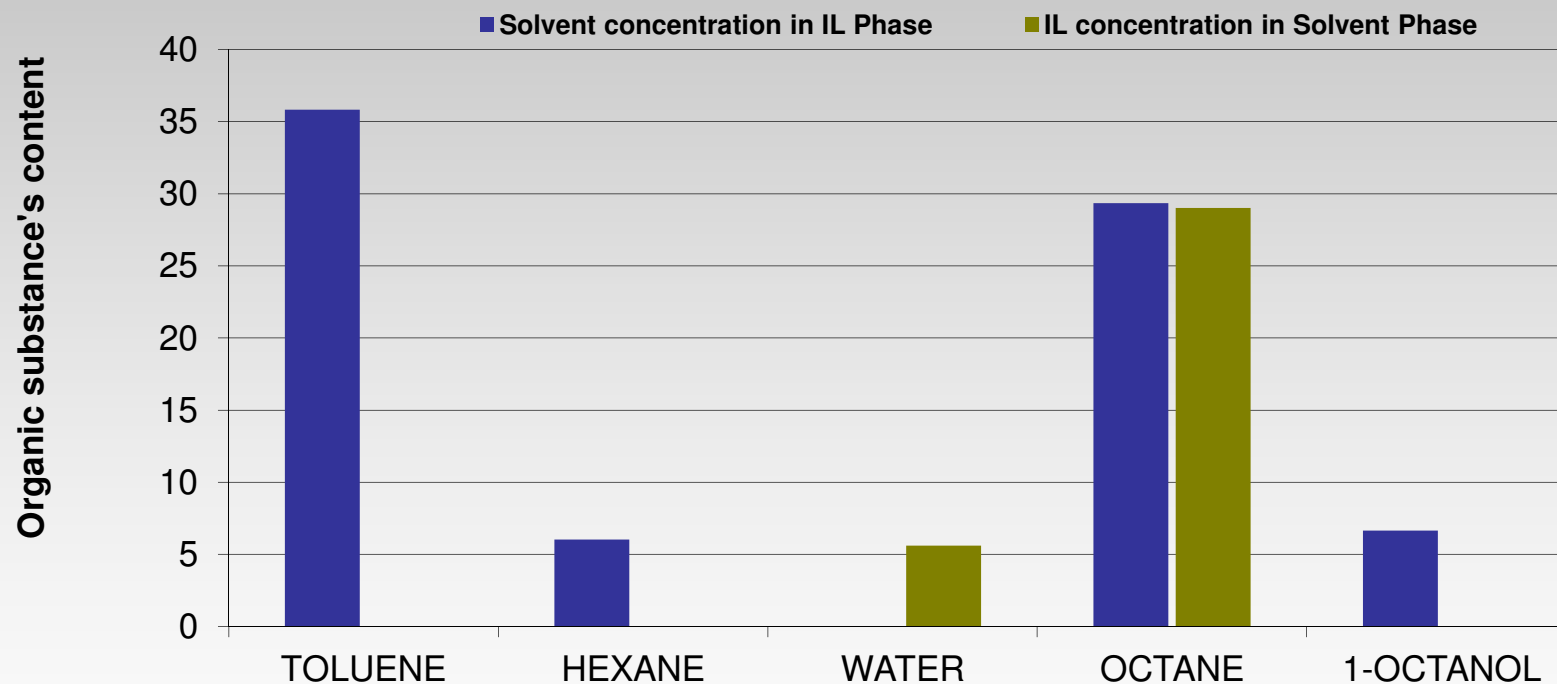
Solubility of 1,3-Dimethylimidazolium Dimethylphosphate



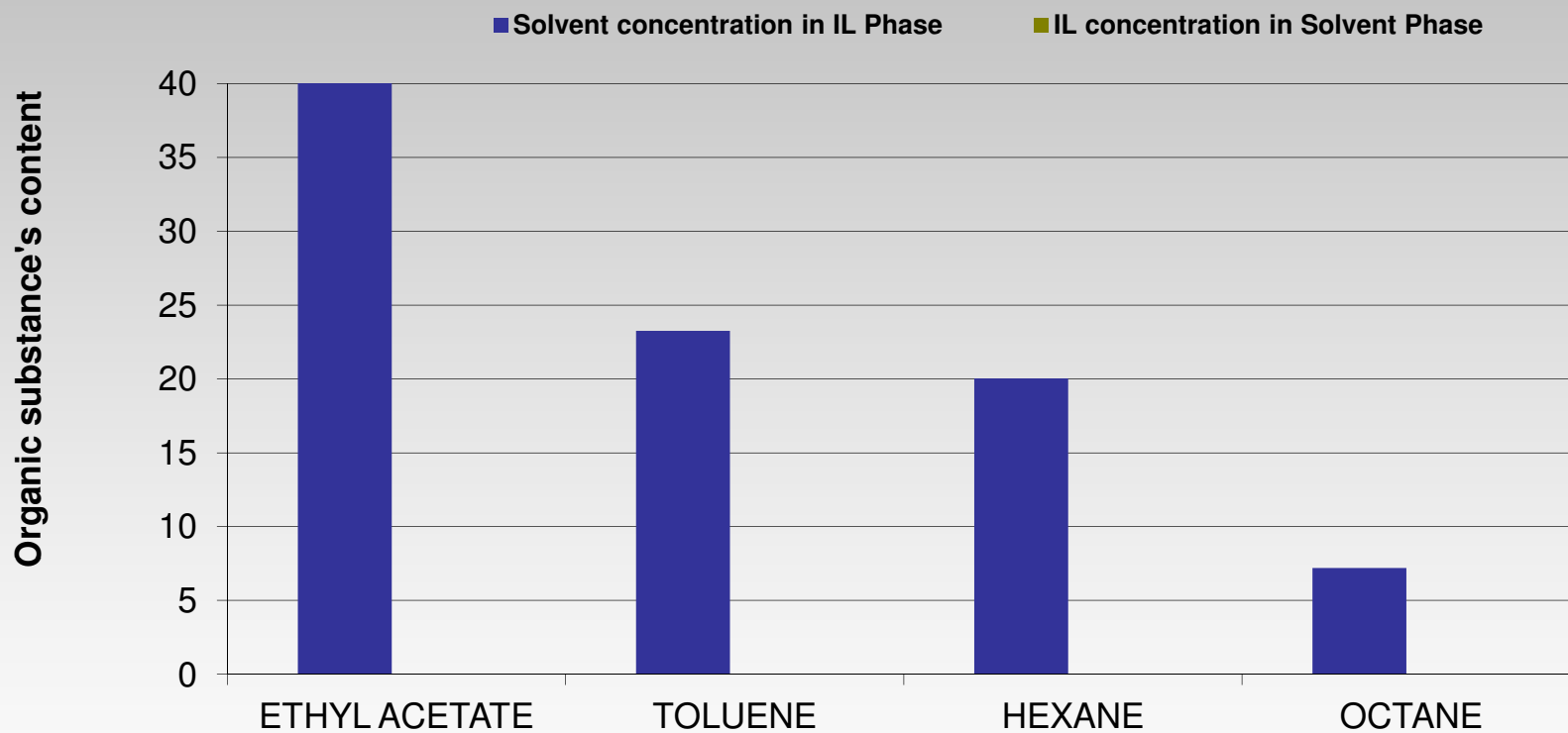
Solubility of 1-Ethyl-3-Methylimidazolium Diethylphosphate



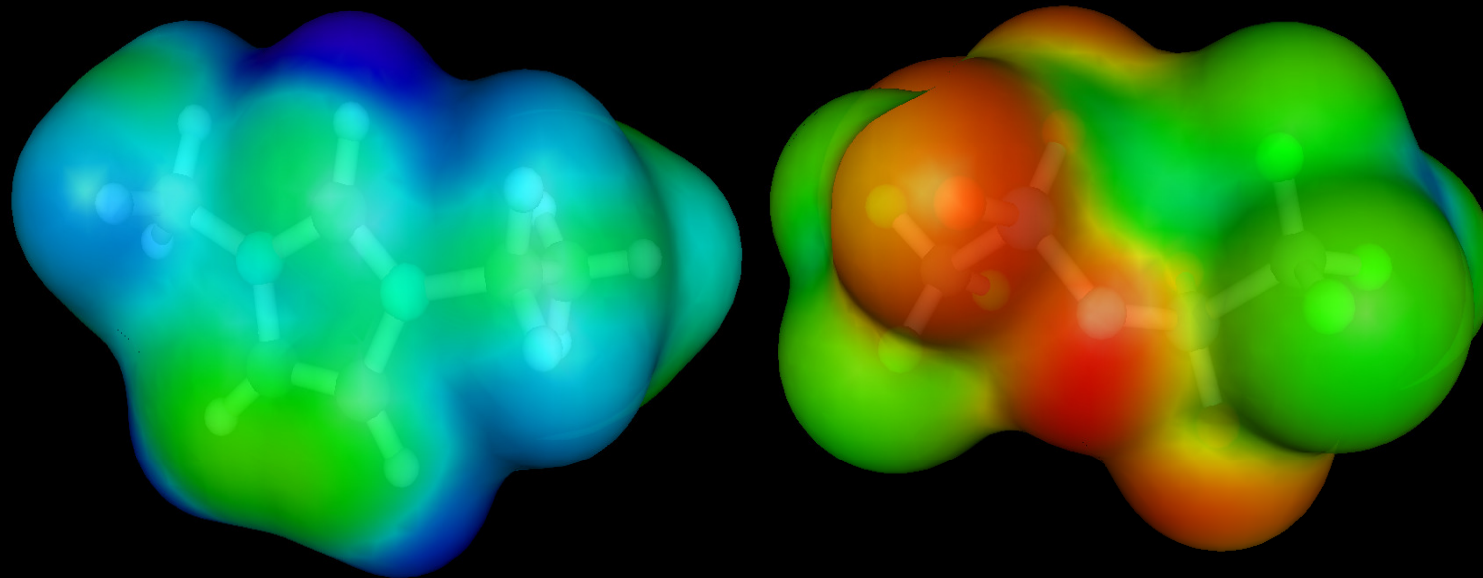
Solubility of *N*-Butyl-*N*-Methylpyrrolidinium Bis(trifluormethylsulfonyl)imide



Solubility of 1-Butyl-3-Methylimidazolium Dicyanamide



3 Conclusions

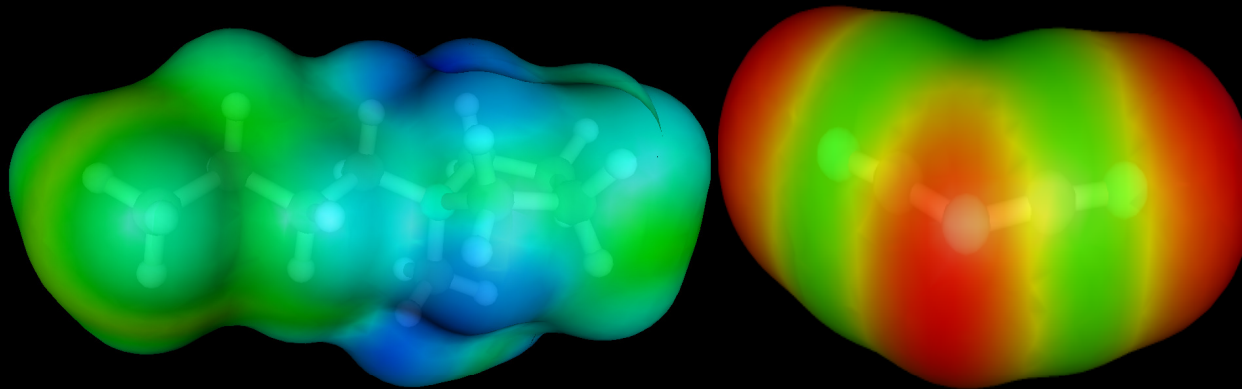


1-Ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide

- ILs are not generally soluble in Acetone; why?
- Some PF₆ ILs are well water soluble (!)
- ILs which are soluble in AcOEt are water insoluble, and *vice versa*
- Imidazolium-based ILs are better soluble in AcOEt than Pyrrolidinium or even Pyridinium ones
- BTA-based ILs are better soluble in Toluene than the corresponding PF₆ and BF₄ ILs
- PF₆ and BF₄ - based ILs are better soluble in Hexane than the corresponding BTA ILs

We still do not understand enough in order to predict solubility.

IOLITEC – *Enabling success in future technologies*



***N*-Butyl-*N*-methylpyrrolidinium dicyanamide**

IOLITEC since 01/2010 @ Heilbronn, Germany
since 02/2010 @ Tuscaloosa, USA
(2003-2005 Freiburg)
(2005-2009 Denzlingen)

Foundation: 2003

Branch: Chemistry / Material Science

Capacity: 10 mT (2010)
fast Scale-Up
2011: 25-100 to per year

Products: ~ 300 ionic liquids
10 in bulk-quantity
~ 130 Nanomaterials
2011: New Dyes for DSSCs

Customers: > 1'400 worldwide

Employees: 20
(8 PhD Chemists)



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Heilbronn, Germany



Tuscaloosa, Alabama, USA

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Heilbronn, Germany



Heilbronn, Germany

Ionic Liquids

Available:

- R&D-Chemicals:
> 300 products
& custom synthesis
- special-chemicals:
10 products in bulk
quantities available
brands: IOLILyte®
IOLITive®

Applications:

- solvents
- process chemicals
- functional fluids
- Surfactants...

Nano-Technology

Available:

- Nanoparticles:
125 products
metals, metal oxides
CNTs, carbides
- nanoparticle-
dispersions
& custom synthesis
brand: IOLIDispers®

Applications:

- coatings
- abrasives
- lubricants
- additives...

Energy/Cleantech

Available:

- Ready-to-use
electrolytes for dye
sensitized solar
cells (DSSCs)
- sensor-electrolytes

Market entry 2011/12:

- materials for
heat storage and
- transport
Brand: IOLITherm®
- Electrolytes for bat-
teries & Supercaps



Your Partner in

- *Ionic Liquids*
- *Key Intermediates:*
 - *N-Heterocycles*
 - *Fluorinated Compounds*
- *Nano-Materials*

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