Ionic Liquid Precursors for Multicomponent Inorganic Nanomaterials

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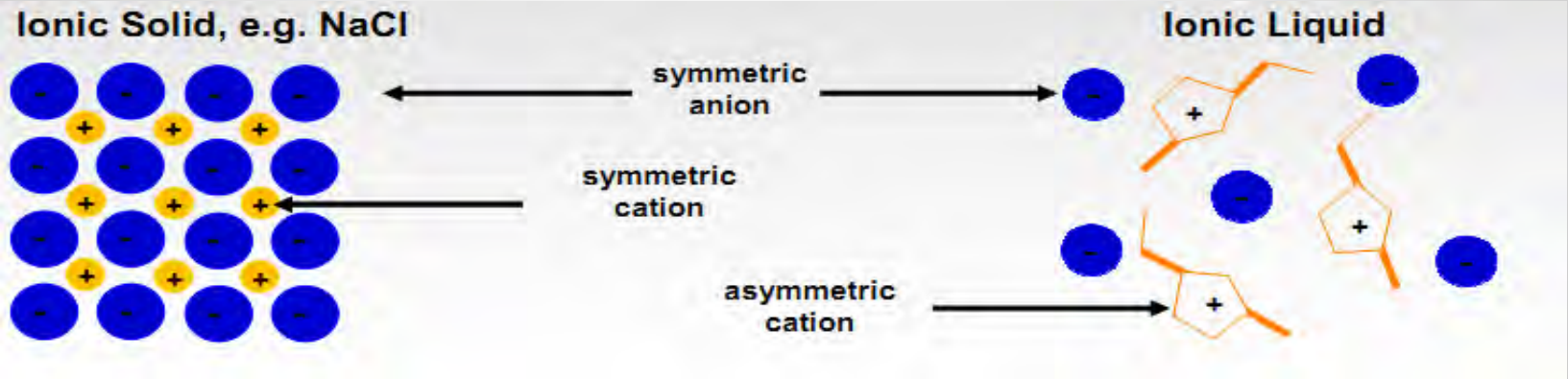
Outline

- What are ionic liquids?
- Properties of ionic liquids
- Liquid Crystals
- Overview on project
- Synthesis of Ionic Liquids
- Characterization
- Conclusion

What are ionic liquids?

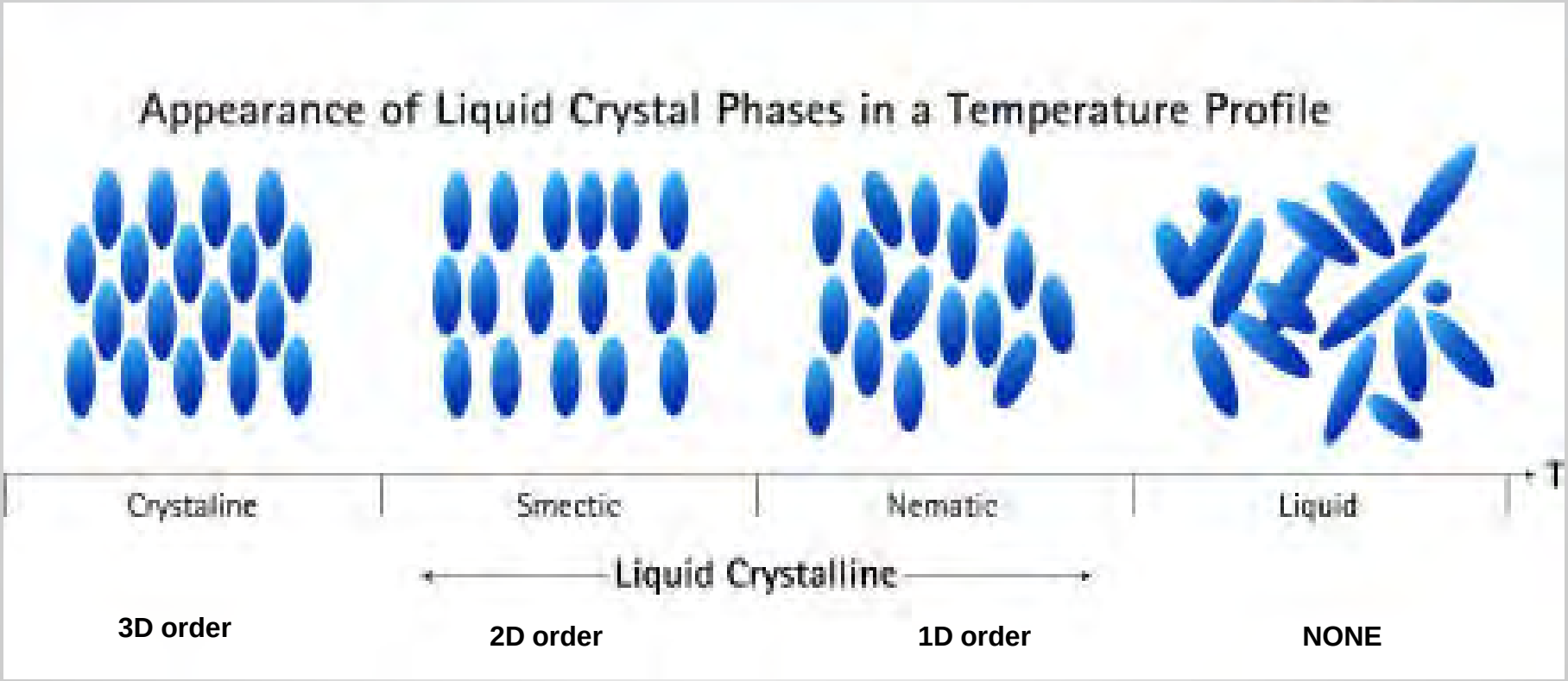
- **An ionic liquid (IL) is a salt in the liquid state that have a melting point below 100°C.**
- **Ionic liquid consists of a cation, which is normally a bulk organic structure with low symmetry and an anion, which may be organic or inorganic.**



Properties of ionic liquids

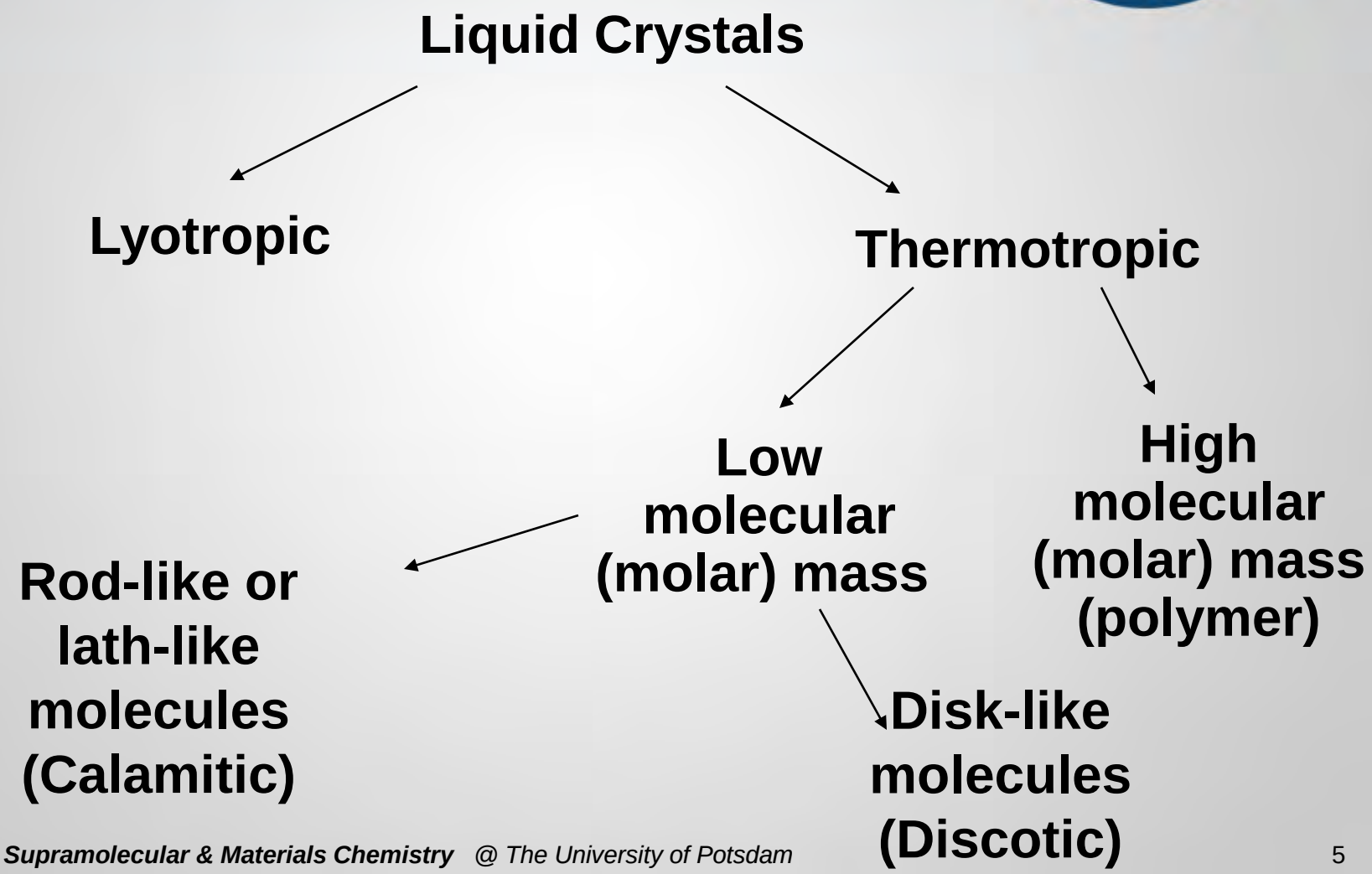
- High thermally stable
- Electrochemically stable
- Broad liquid range
- High Viscosity
- Very low vapor pressure
- Non-flammable substance
- Low toxicity
- Non-volatility

Liquid crystals



Higher order $\xrightarrow{\triangle}$ **Lower order**

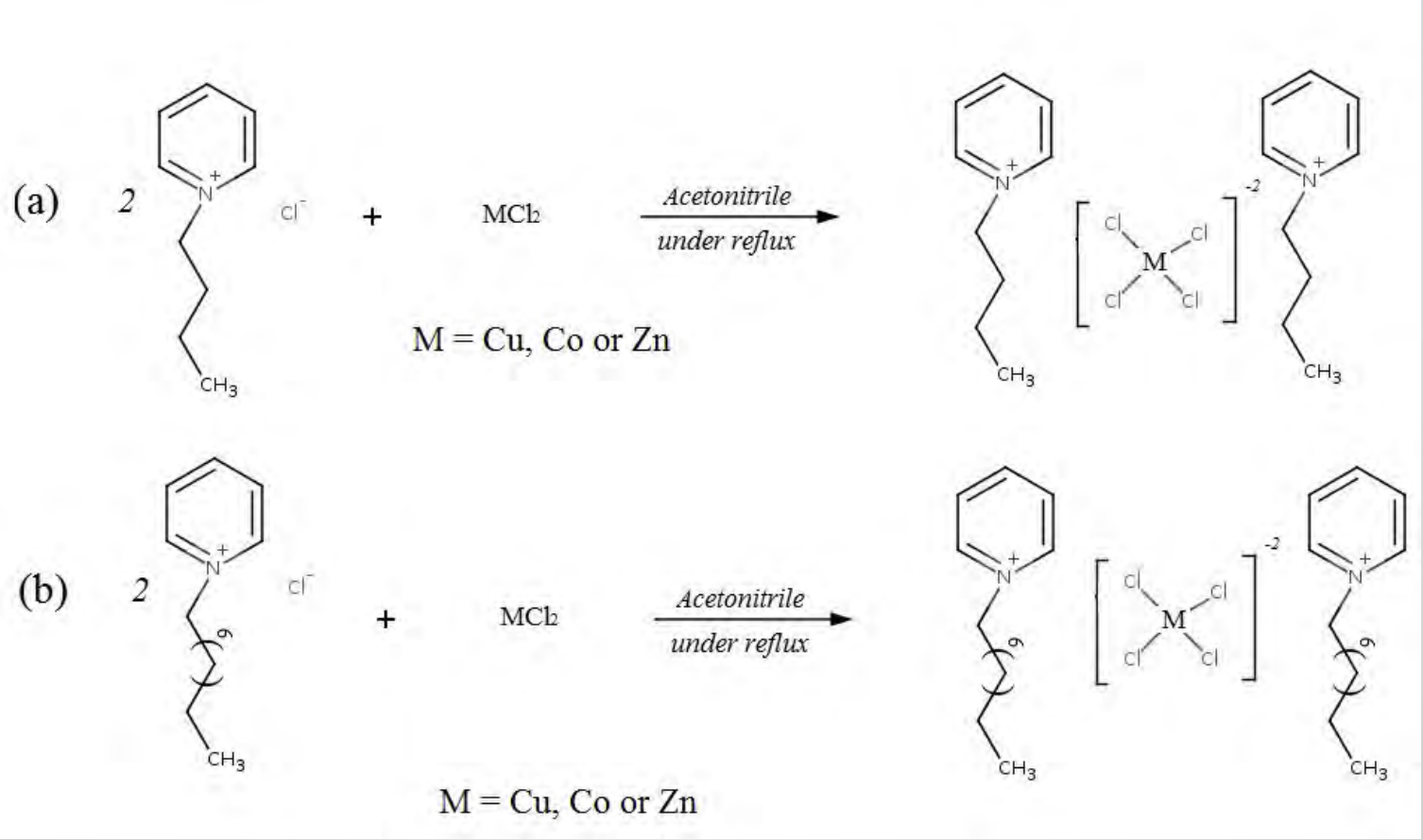
Types of liquid crystals



Overview on Project

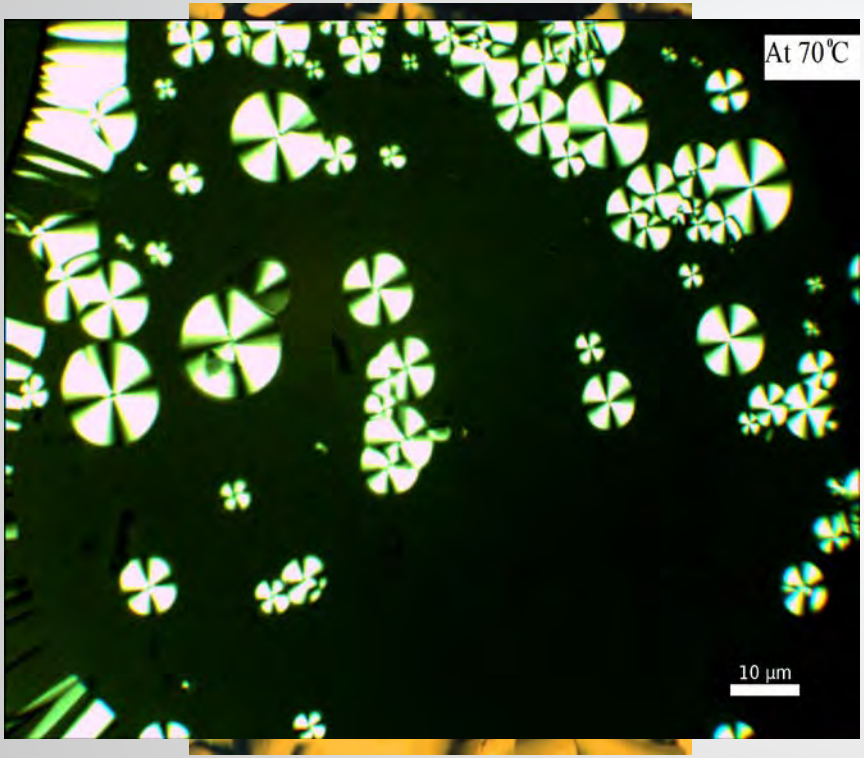
1. Synthesis and characterization of ionic liquid precursors (ILPs)
2. Growth of sulfides
3. Transformation to metal chalcogenides – minerlization mechanism
4. Atomic, nano, and mesoscale structure of the minerlization products
5. Upscaling and thin film preparation
6. Semiconductor solar cell

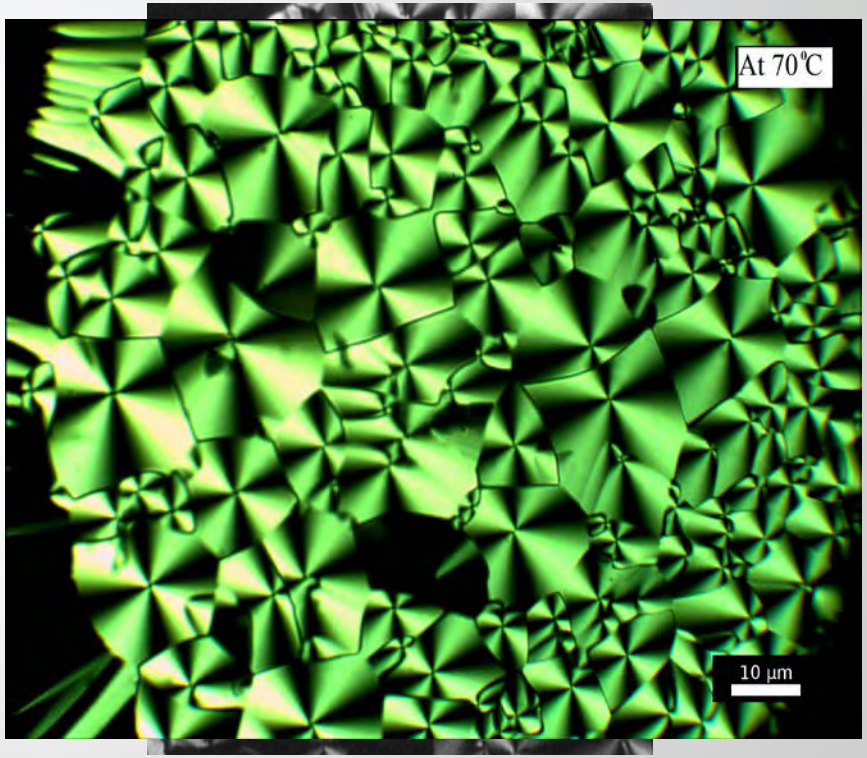
Preparation of ILs



(a) Kerstin Thiel, Phys. Chem. Chem. Phys., 2011, 13, (b) F. Neve, Chem. Mater., 2001, 13 and Christopher J. Bowlas Chem. Commum., 1996

$[C_{12}Py]_2\,[MCl_4]$





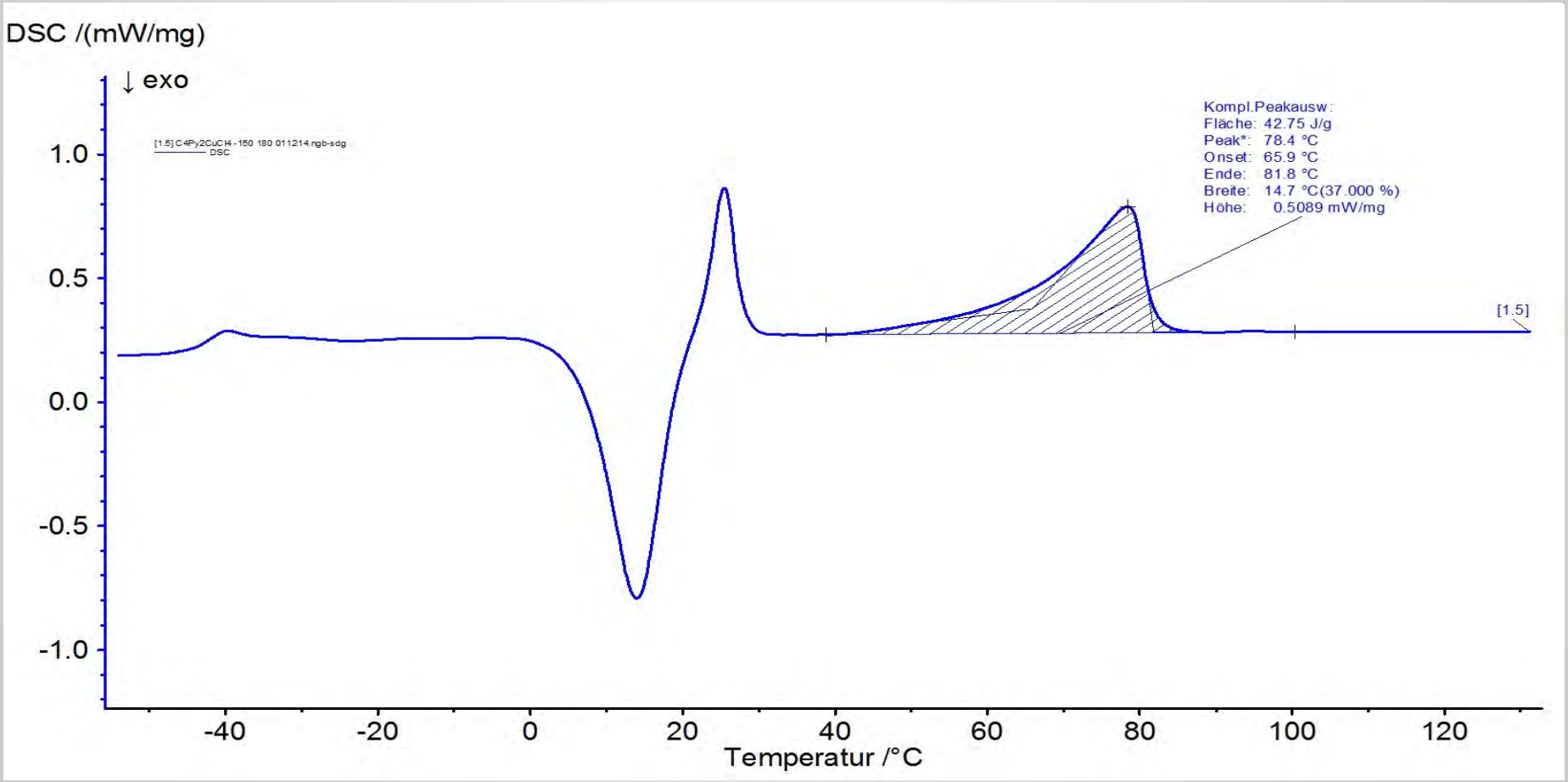
$[C_{12}Py]_2\,[CuCl_4]$ $[C_{12}Py]_2\,[ZnCl_4]$ $[C_{12}Py]_2\,[CoCl_4]$

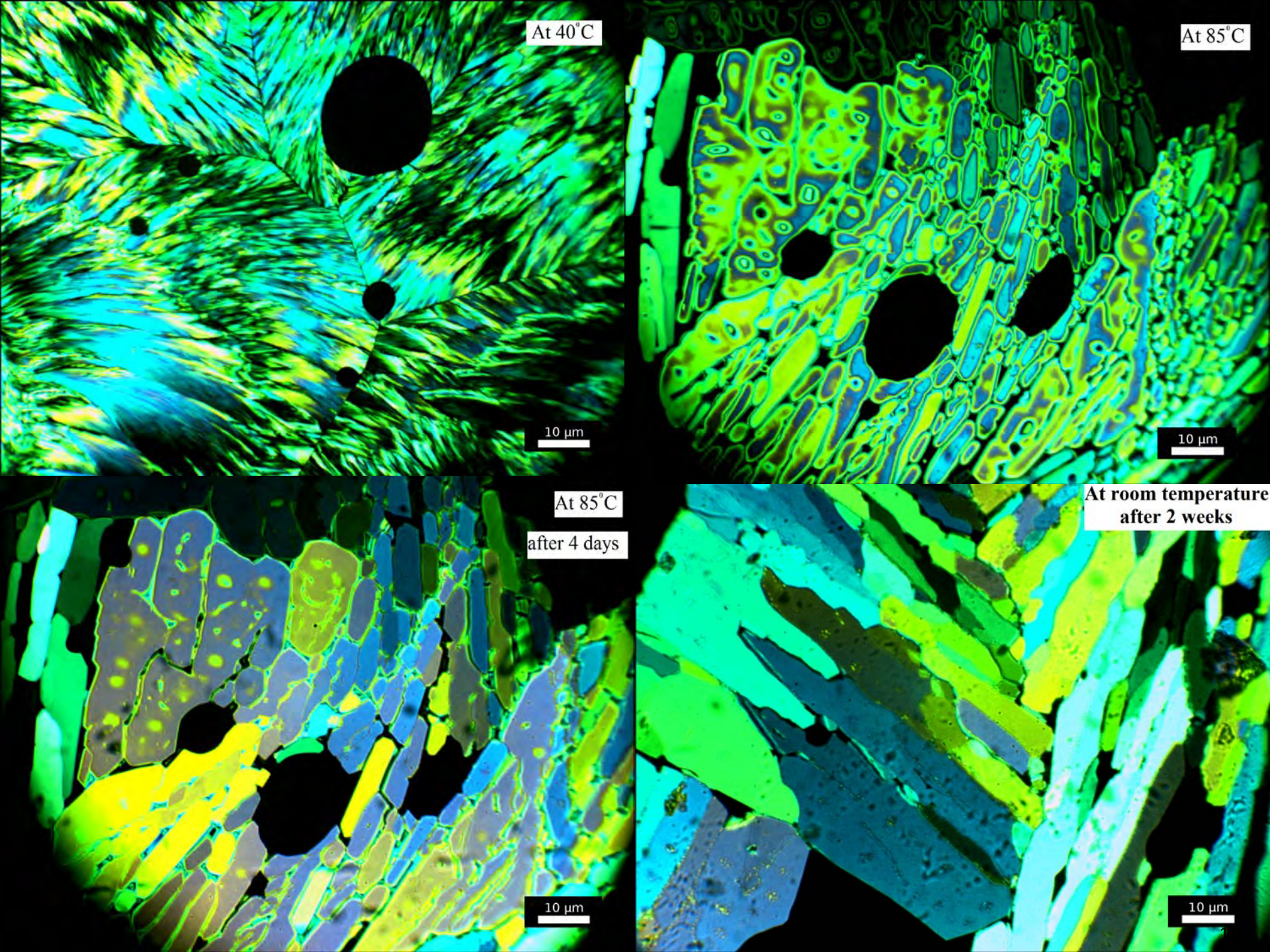
F. Neve, Chem. Mater., 2001, 13

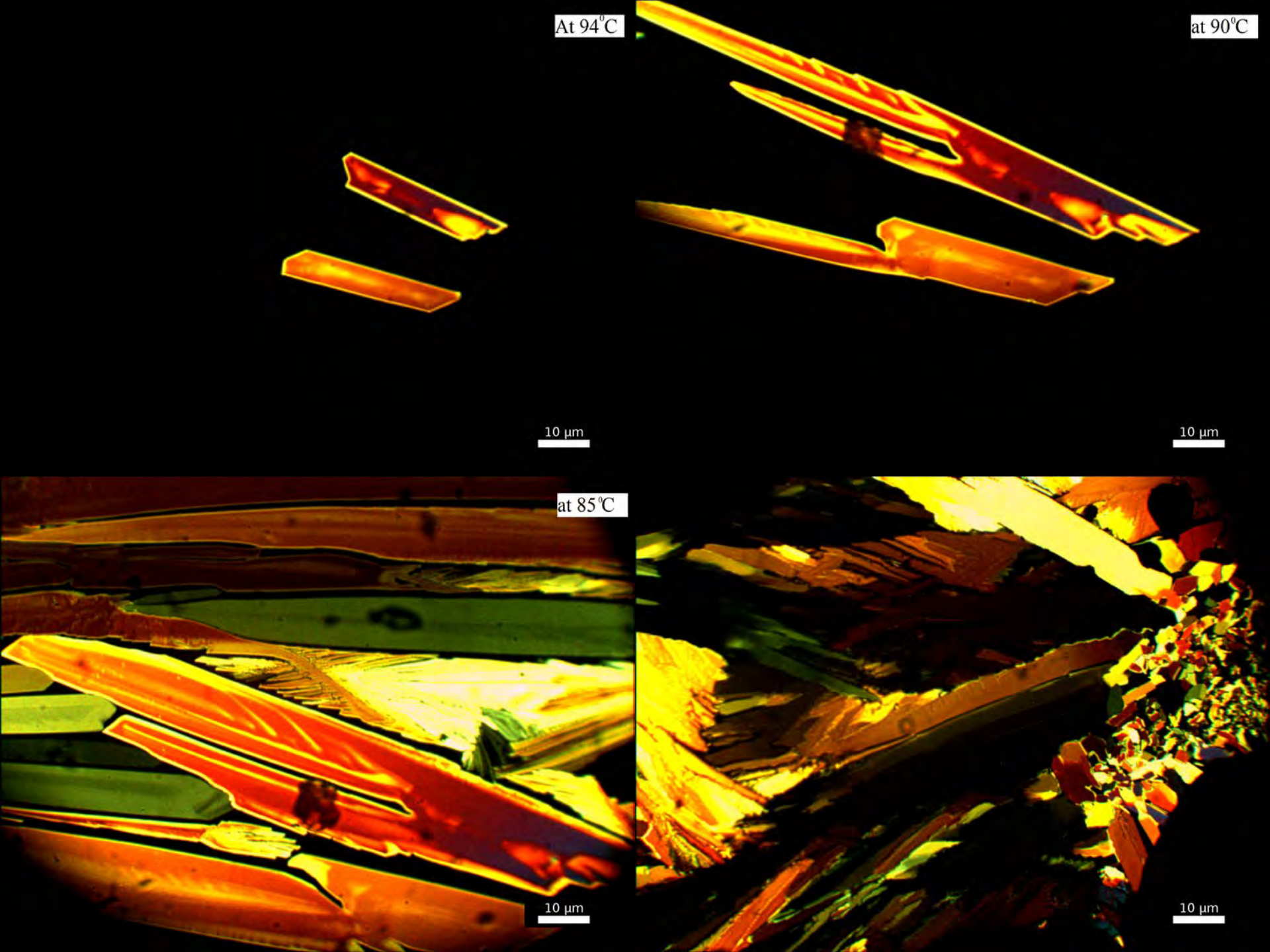
Christopher J. Bowlas Chem. Commum., 1996

Liquid crystal.avi

$[C_4Py]_2\,[CuCl_4]$

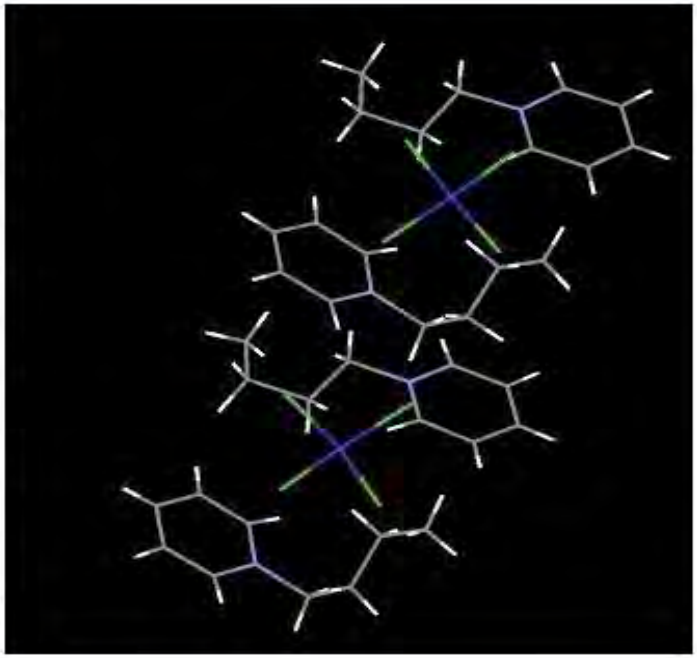

DSC /(mW/mg)
↓ exo
[1.5] C4Py2CuCl4 - 150 180 011214.ngb-sdg
DSC
Kompl.Peakausw:
Fläche: 42.75 J/g
Peak*: 78.4 °C
Onset: 65.9 °C
Ende: 81.8 °C
Breite: 14.7 °C(37.000 %)
Höhe: 0.5089 mW/mg
[1.5]
1.0
0.5
0.0
-0.5
-1.0
-40
-20
0
20
40
60
80
100
120
Temperatur /°C


At 40°C
10 µm
At 85°C
10 µm
At 85°C
after 4 days
10 µm
At room temperature
after 2 weeks
10 µm


At 94°C
10 µm
at 90°C
10 µm
at 85°C
10 µm
10 µm

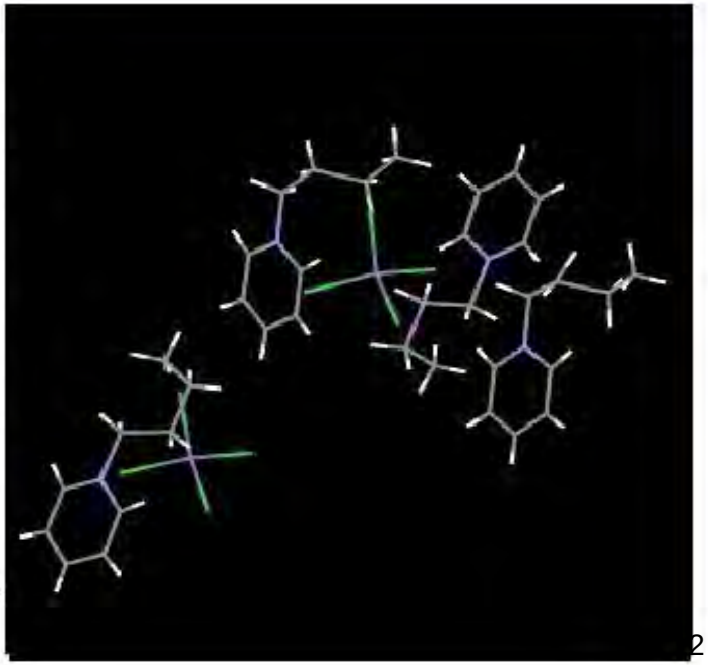
Single-crystal X-ray Diffraction

Empirical formula	$C_{18}H_{28}C_{14}CoN_2$
Formula weight	473.15
Temperature	210(2)K
Crystal system, space group	Monoclinic, P $2_1/n$
Unit cell dimensions	a = 15.3539(4)Å
	b = 18.7109(4)Å
	c = 16.7085(4) Å
	$\alpha = \gamma = 90°$
	$\beta = 110.526(2)°$



Single-crystal X-ray Diffraction

Empirical formula	$C_{18}H_{28}C_{14}N_2Zn$
Formula weight	479.59
Temperature	210(2)K
Crystal system, space group	Monoclinic, P $2_1/n$
Unit cell dimensions	a = 15.3418(5) Å
	b = 18.7196(8) Å
	c = 16.7117(5) Å
	$\alpha = \gamma = 90°$
	$\beta = 110.420(2)°$



Conclusion

- **We successfully synthesised ILs and ILCs.**
- **We verify the phase behaviour of the ILs and ILCs to determine which liquid crystalline phases are obtained vs. chemical composition.**

Our future Plan

1. **We will continue the characterization methods to get all chemical and structure informations.**
2. **We will investigate the miscibility of the ILs and ILCs.**
3. **Transformation of the ILPs to metal chalcogenides.**
4. **Provide a fundamental understanding of the structure-property relations of the product.**

Thank you for your attention