

How Much is Too Much? Testing the Boundaries of Hydrogen Bonded Liquid Crystal/Inhibitor Networks



Our Patron Saint:
The Egyptian God
of Frustrated
Scientists

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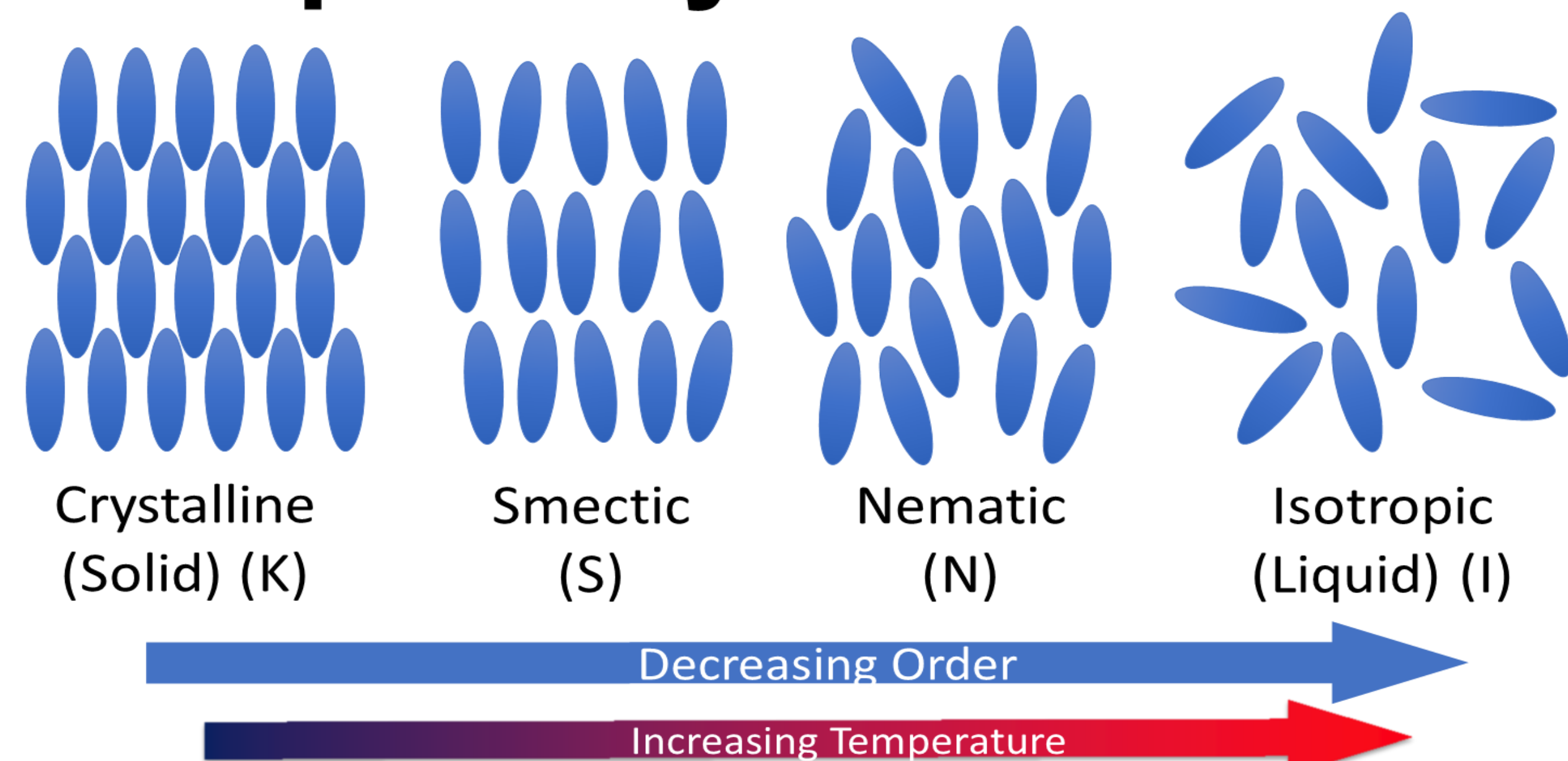
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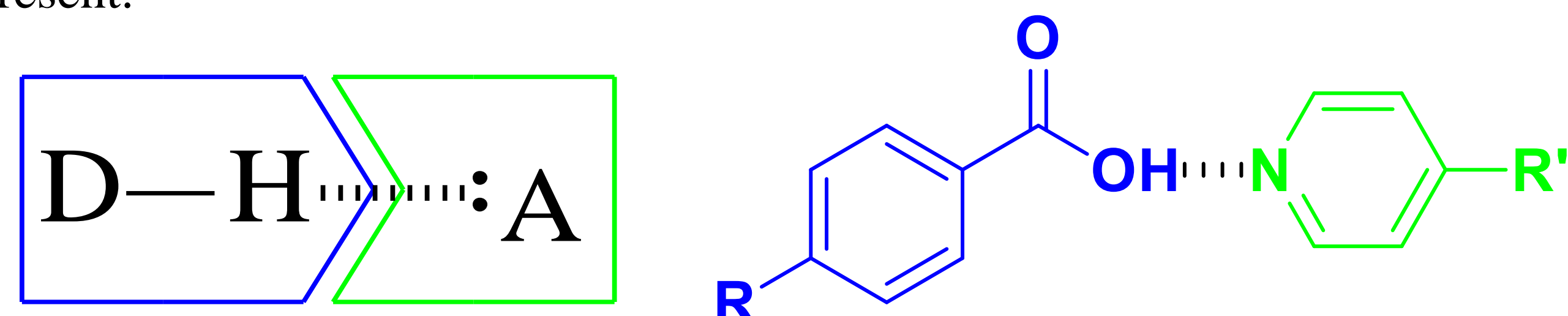
Introduction

A liquid crystal is state of matter that simultaneously displays properties of both a liquid and a solid. Liquid Crystals have applications in liquid crystal displays (LCD's) and optical imaging. Liquid crystals or "mesogens" are created when molecules have both core (ex. aromatic) and chain (ex. alkyl group) structures. This allows the molecule to form a semi-ordered phase in between a solid and a liquid. In this experiment, liquid crystallinity was induced thermally to form rod-like semi-ordered phases.

Liquid Crystal Phases



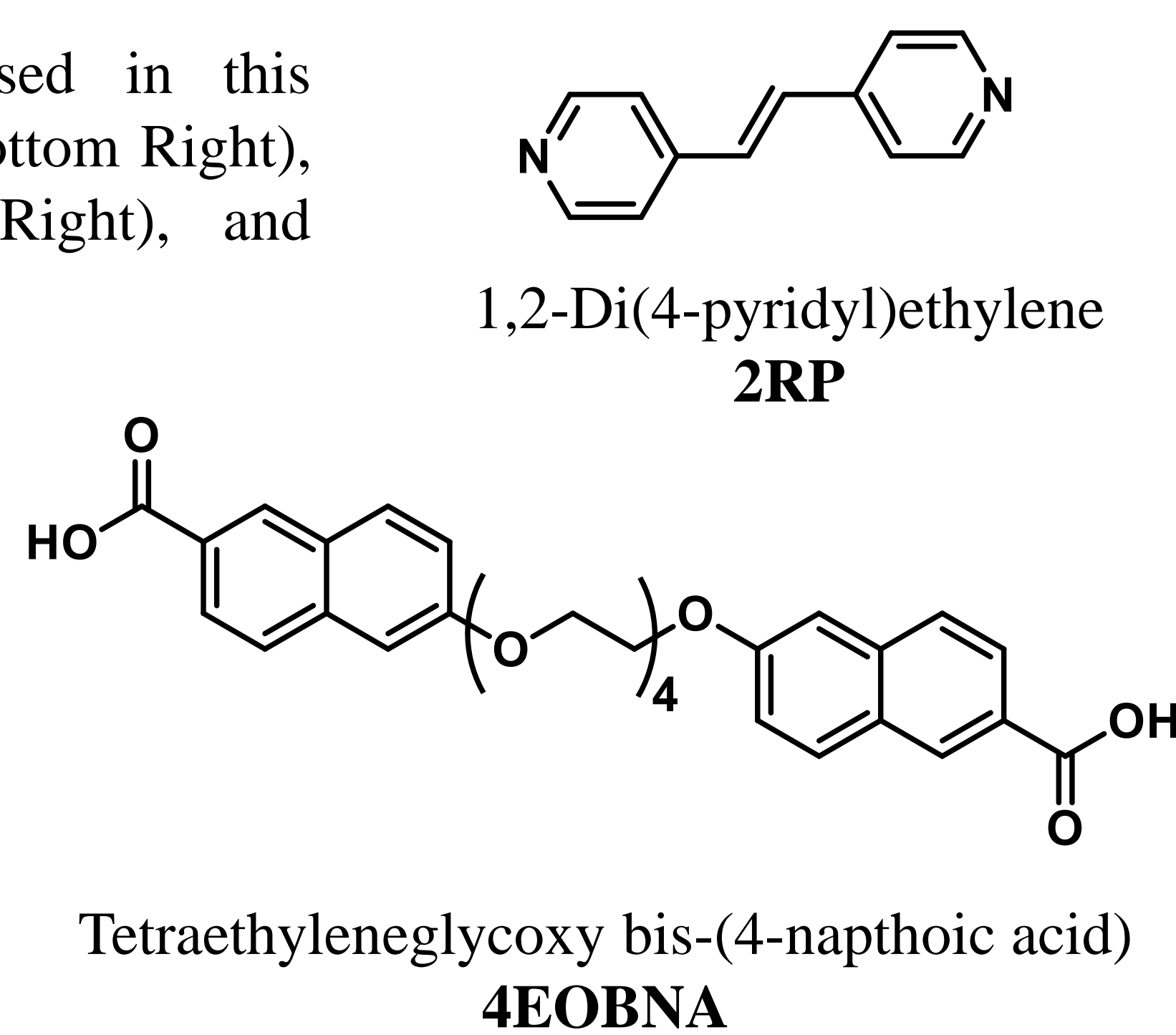
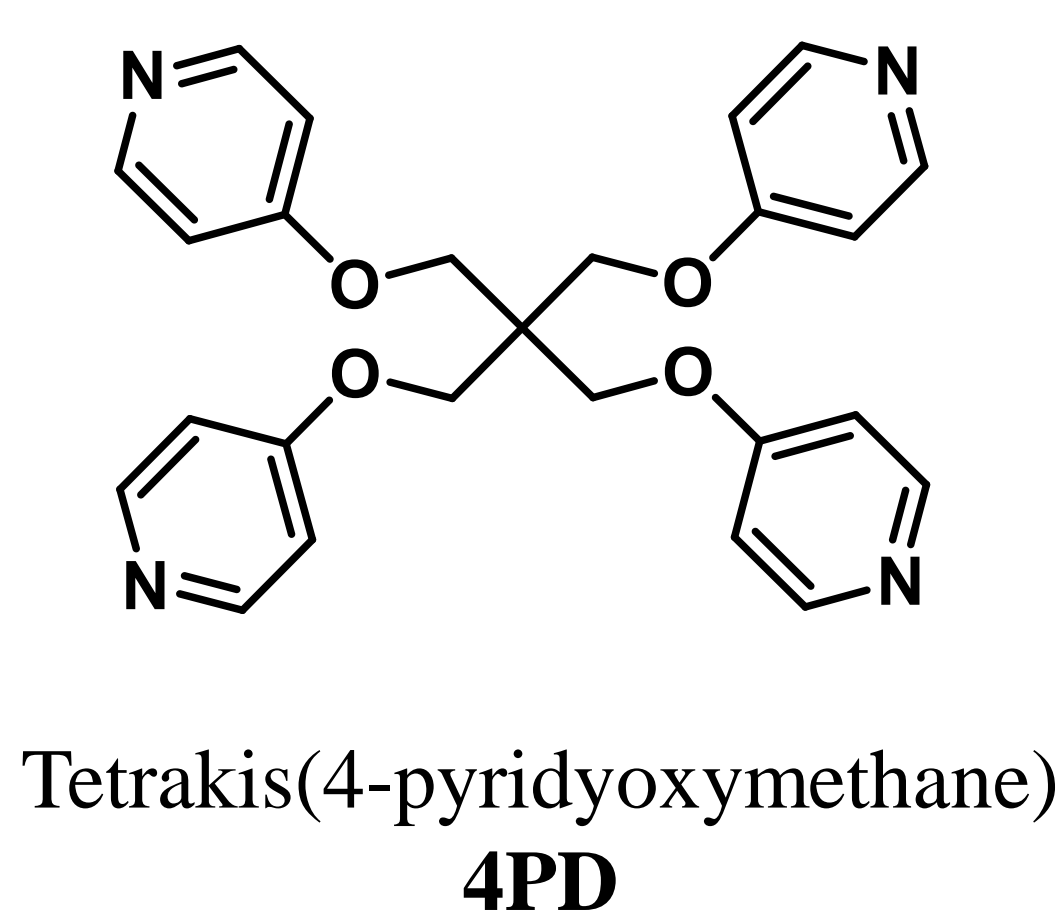
The bisacid donor tetraethyleneglycoxy-bis-4-naphthoic acid (4EOBNA) was used as the primary hydrogen bonding donor. 1,2-di(4-pyridyl)ethylene (2RP) was used as primary hydrogen bonding acceptor. Inducing liquid crystallinity creates mesogenic properties that can display network properties. When heated and cooled, molecules melt and are free to align based on the hydrogen bonds that are formed. This system allows us to tune liquid crystallinity with both temperature and amount of hydrogen bonding present.



Disruption of the balance between core and chain components in a liquid crystal can lead to loss of liquid crystallinity. This project investigates the impact of varying the mole percent of hydrogen bond acceptor (2RP) to flexible hydrogen bond donor (4EOBNA) by using differential scanning calorimetry and polarizing light microscopy. This study uses means of "controlled contamination" with the inhibitor tetrakis(4-pyridoxymethane) (4PD) to show how the mole percent of this inhibitor affects the mesogenic properties of these complexes. Additionally, studying the mesogenic properties of these complexes will give us a better understanding of liquid crystal design for potential application use.

Materials Used

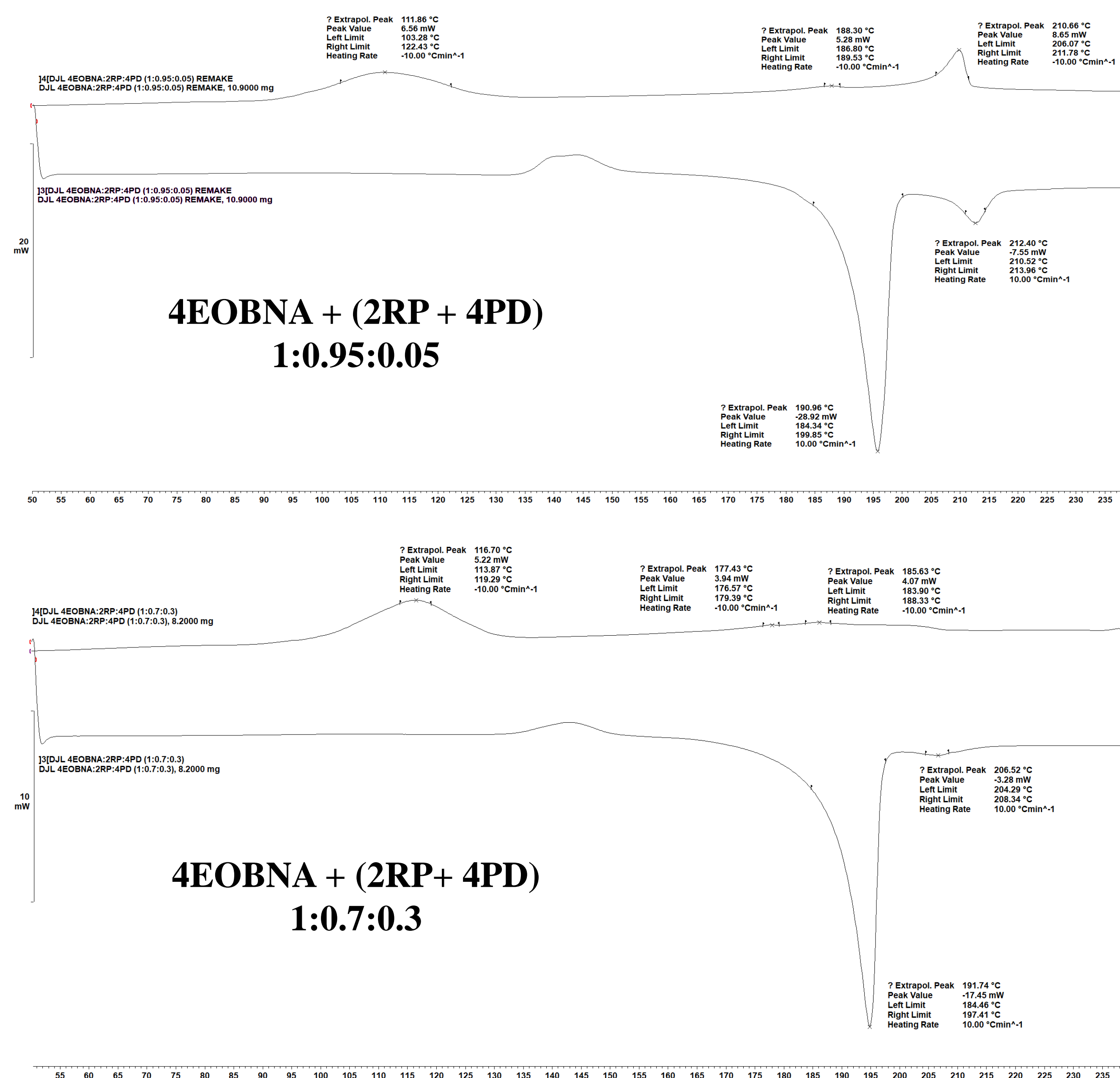
These are the molecules used in this experiment: Bisacid Donor (Bottom Right), Hydrogen Bond Acceptor (Right), and Inhibitor (Bottom Left)



Thermal Analysis

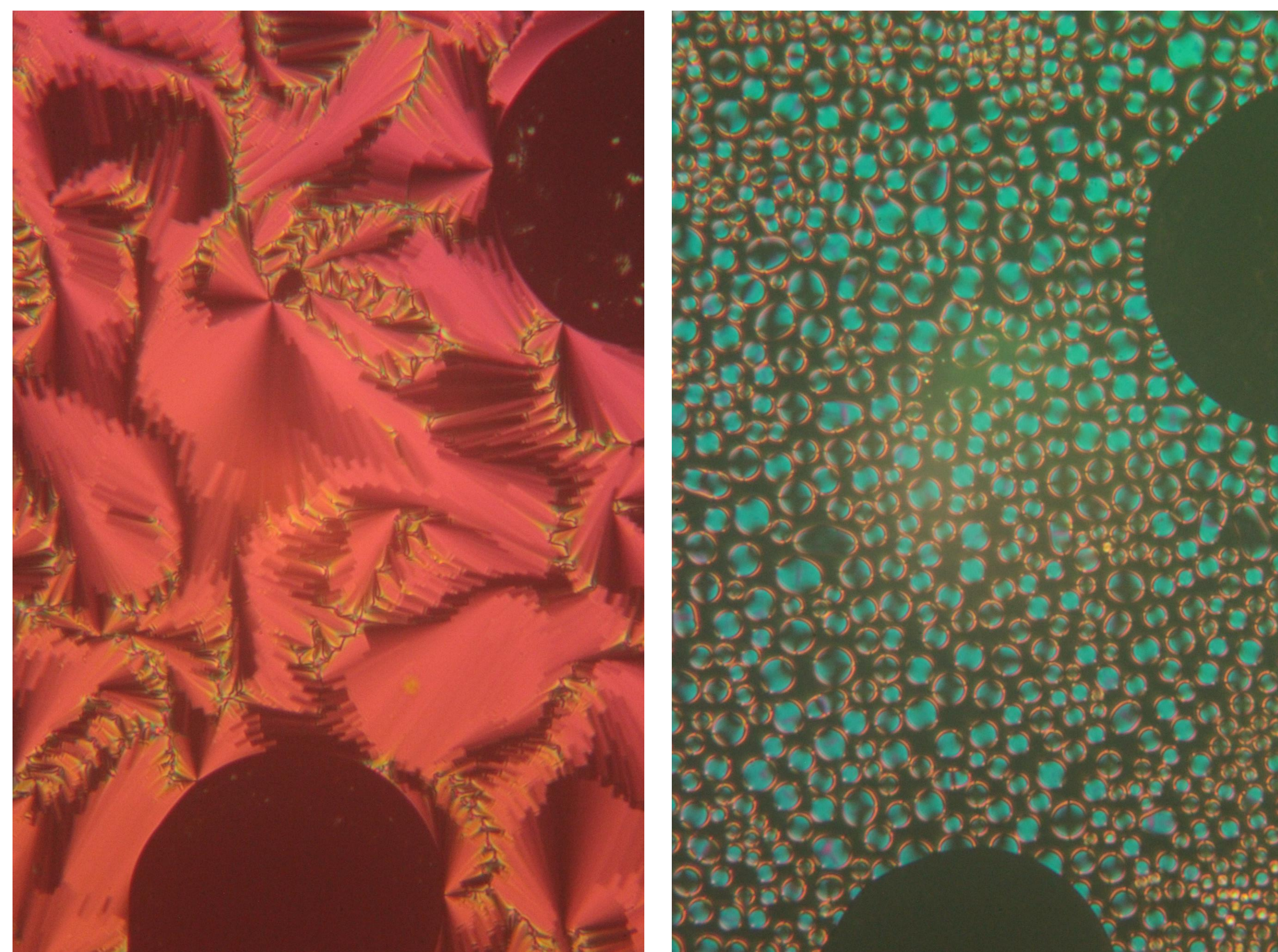
We studied our complexes using two different methods of thermal analysis. The first was differential scanning calorimetry (DSC) which was used to study thermal energy change in our complexes as a way of determining the temperatures where phase changes were occurring. The second method was through the use of polarizing light microscopy which allowed for visual corroboration of the phase changes proposed by DSC.

Differential Scanning Calorimetry (DSC)



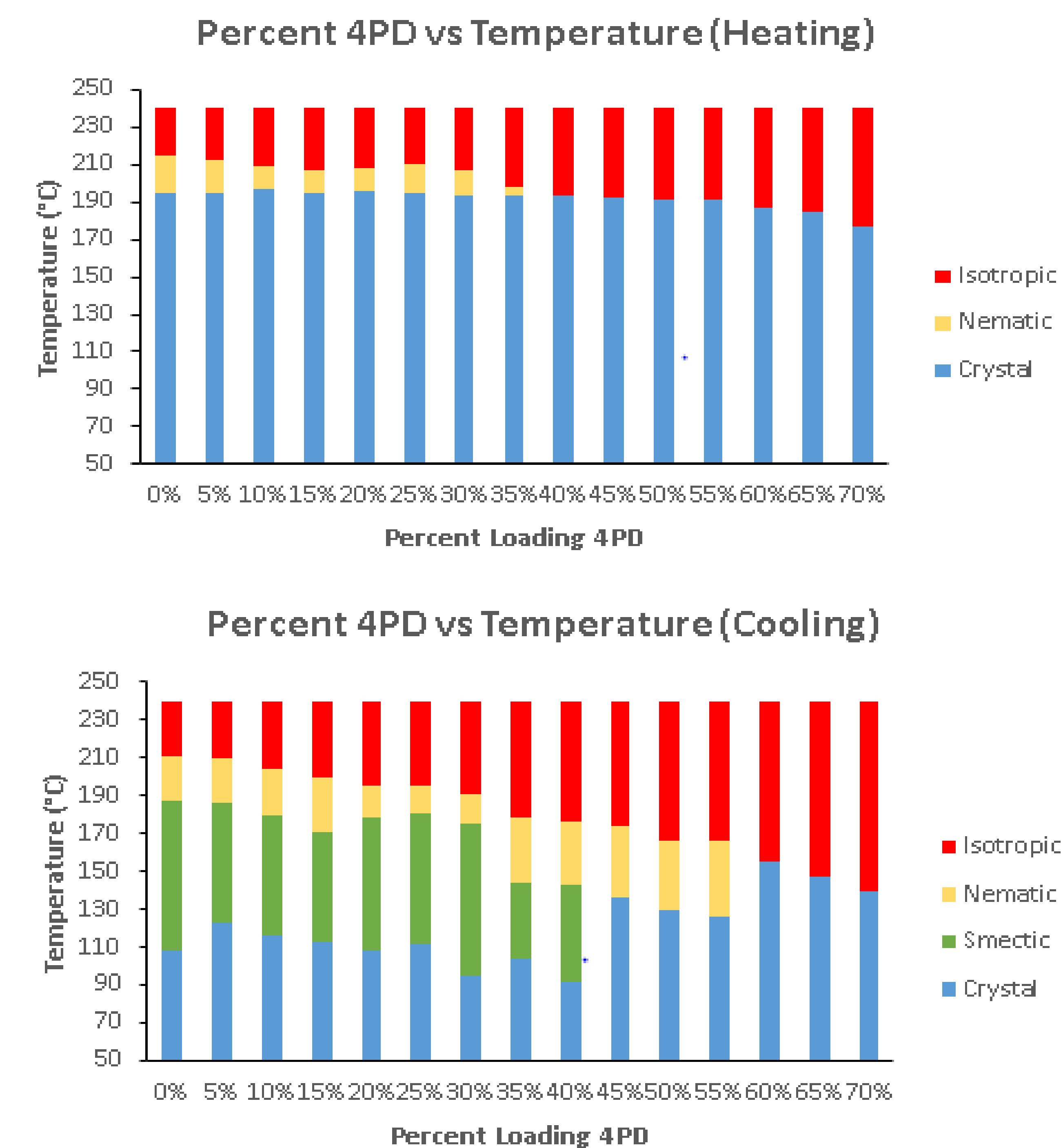
These curves show the peaks which indicate liquid crystal transitions and the general effect of which the inhibitor has on the liquid crystal phases.

Polarizing Light Microscopy



On the left is a smectic phase, and on the right is a nematic phase of a 4EOBNA, 2RP (1:1) complex. Both pictures were taken during the cooling of the complex on the same slide

Data Interpretation



These diagrams illustrate the relationship between the molar ratio of acceptor to inhibitor and the phases that a complex exhibits. As the amount of inhibitor in the complex increases, the amount of liquid crystalline behavior decreases until it ultimately dies off at what is known as its "kill point". These two graphs show the phase data for the combination of 4EOBNA, 2RP, and 4PD and the approximate range of its kill point.

Observations/Conclusions

- Liquid crystalline supramolecular polymer was successfully assembled through hydrogen bonding.
- Smectic phases appear to be limited to low percentages of inhibitor inclusion for this series of complexes.
- This polymer exhibits liquid crystalline characteristics up to 55% inhibitor addition into the network.
- These complexes exhibit liquid crystal properties on the heating phase as well as the cooling phase.

Acknowledgements

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