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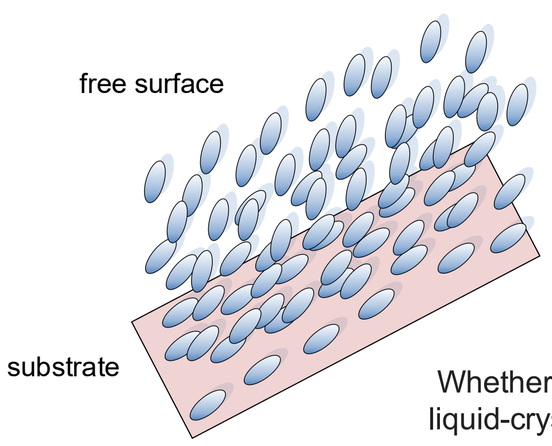
Thin films of non-glassforming liquid crystal: relaxation and vibrational dynamics

Anna Drzewicz
Institute of Nuclear Physics Polish Academy of Sciences, Krakow, POLAND
anna.drzewicz@ifj.edu.pl

Introduction

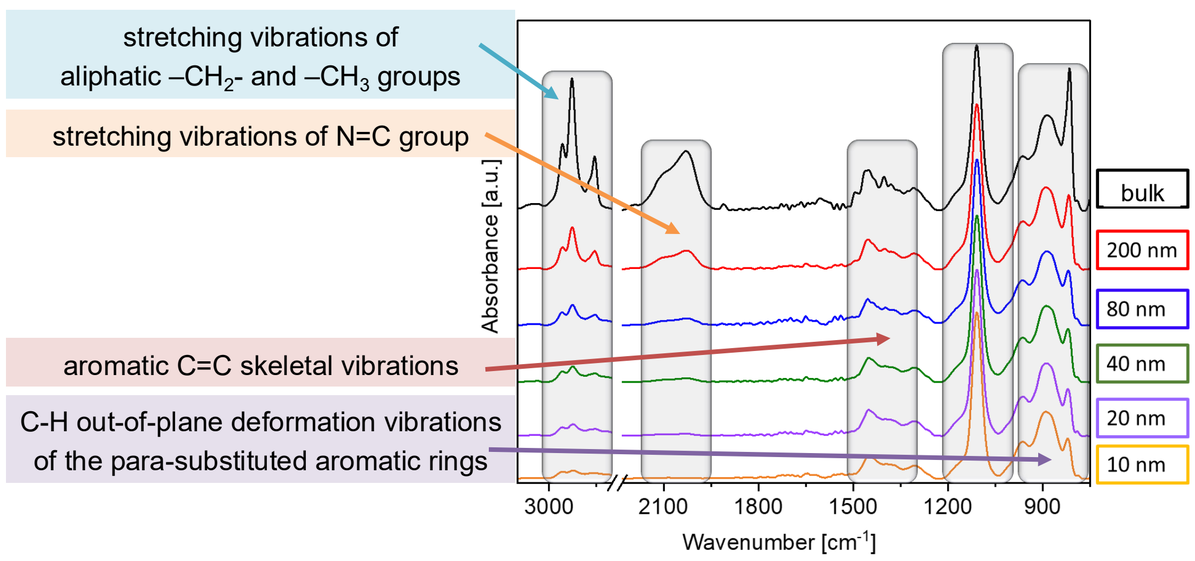
Miniaturization is still prevalent in technology. It is generally observed that the properties of materials at the nanoscale differ from those at the macroscale. However, the reasons for this are still not fully understood, especially in the case of soft materials such as liquid crystals. It seems that the main factor influencing the behaviour of spatially confined systems is the interaction of molecules with the substrate.



Motivation

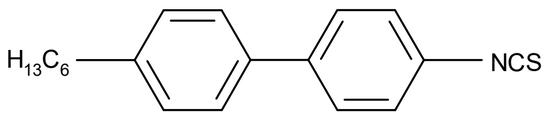
Whether physical vapor deposition of 6BT induces liquid-crystalline ordering in ultrathin film geometry?

Vibrational dynamics of 6BT thin films



Fourier-transform infrared spectroscopy results.

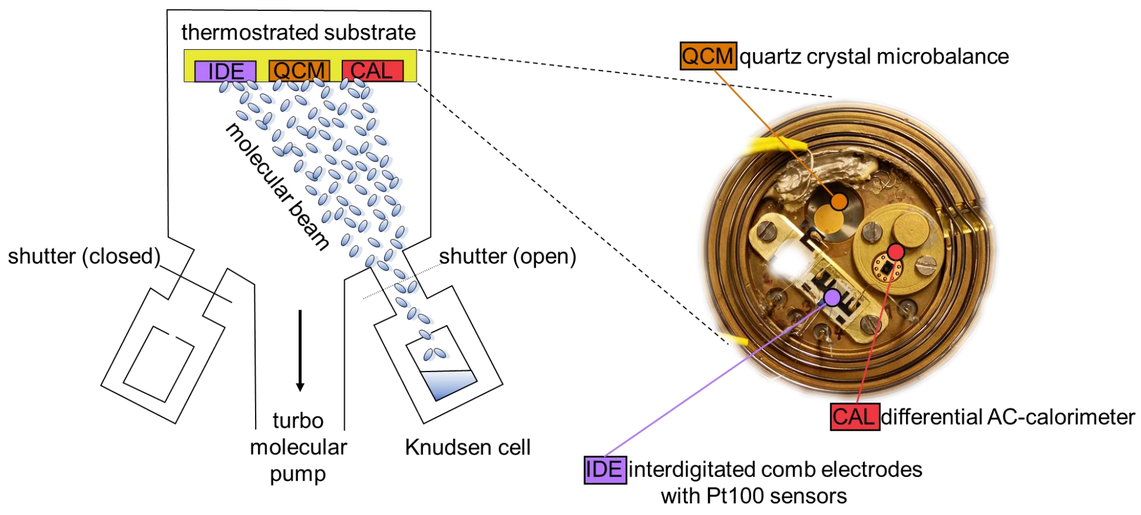
Material



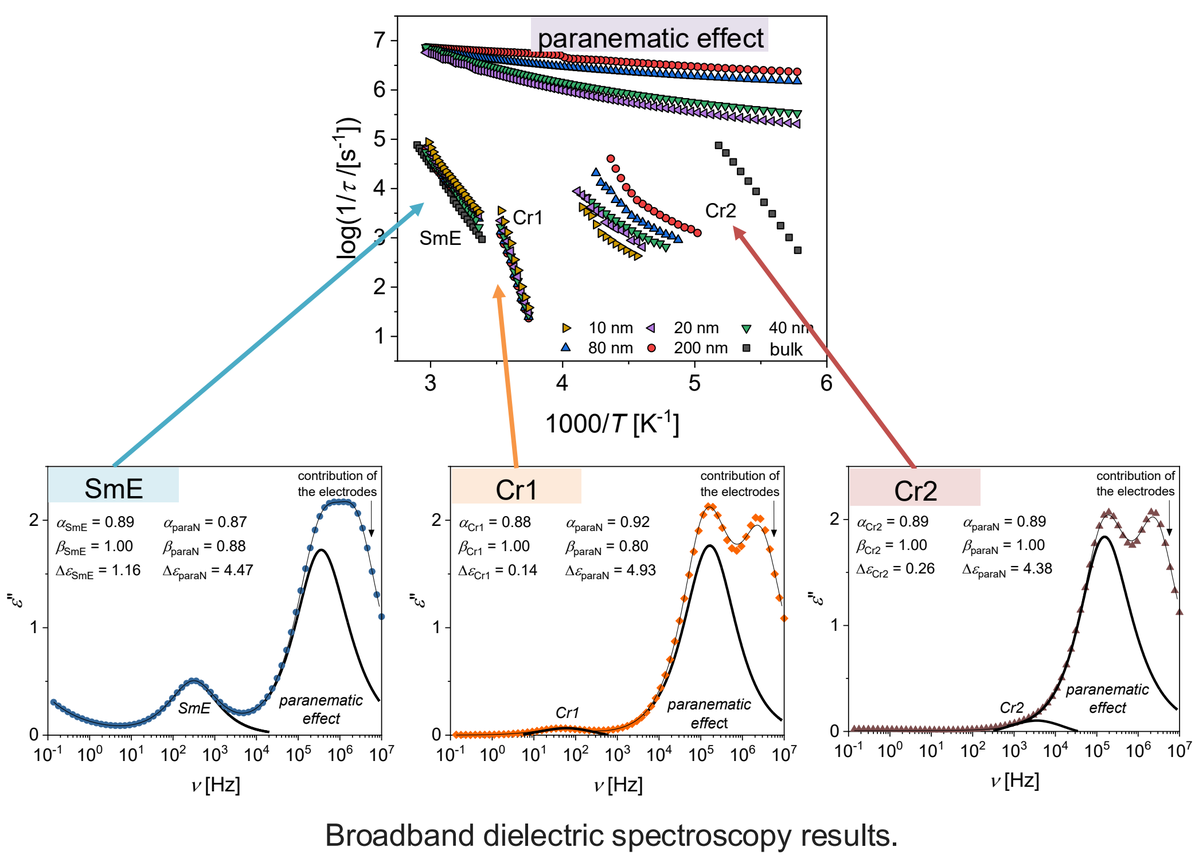
4-hexyl-4'-isothiocyanatobiphenyl (**6BT**)

Creating thin films via OMBD method

OMBD allows the formation of organic thin films in ultra-high vacuum by evaporating the material whose the molecules impinge on a substrate, creating layers.

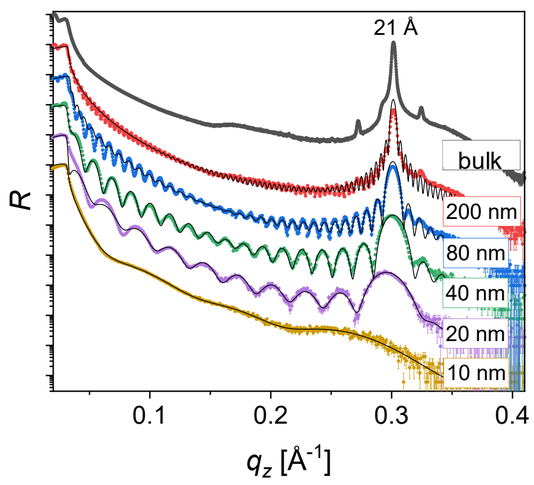


Relaxation dynamics of 6BT thin films

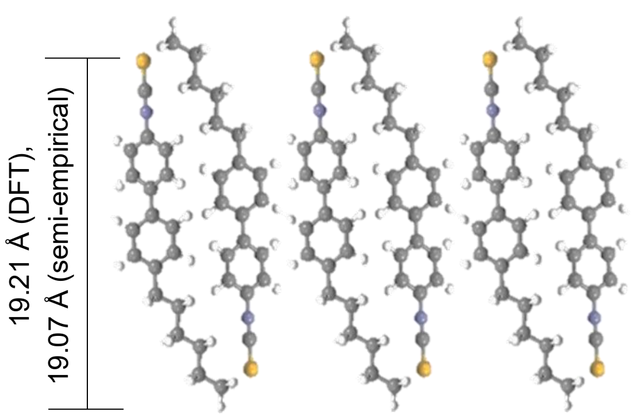


Broadband dielectric spectroscopy results.

Thickness of 6BT thin films

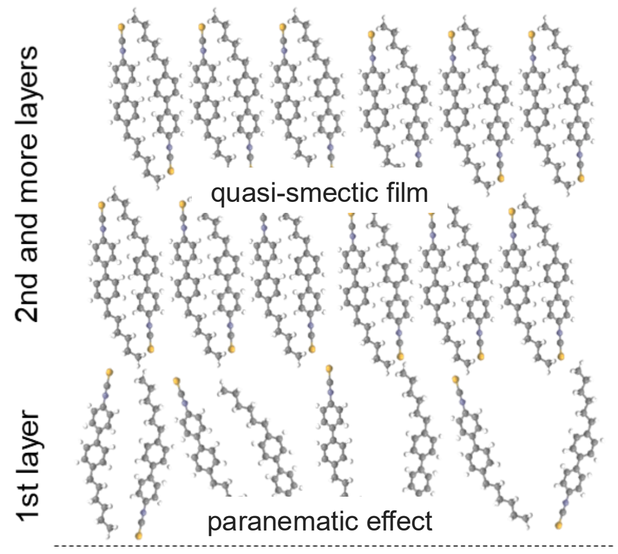


X-ray reflectometry results.



Predicted 'smectic' layer thickness is 21 Å.

Conclusions



- Vibrational dynamics:
FTIR analysis reveals early molecular ordering of aromatic and alkyl segments at low film thicknesses, while –NCS vibrations become dominant in thicker (>40 nm) films.

- Relaxation dynamics:
Bulk-like dynamics are reached only in the SmE phase of ultrathin films, while a high-frequency paranematic process persists across all temperatures.

Based on: A. Drzewicz, M. Krupiński, O. Tomchuk, E. Pięta, G. Lewińska, E. Juszyńska-Gałązka, *Molecular dynamics in thin films of 6BT liquid crystal*, J. Mol. Liq. 437 (2025) 128573.