



TÉCNICO
LISBOA

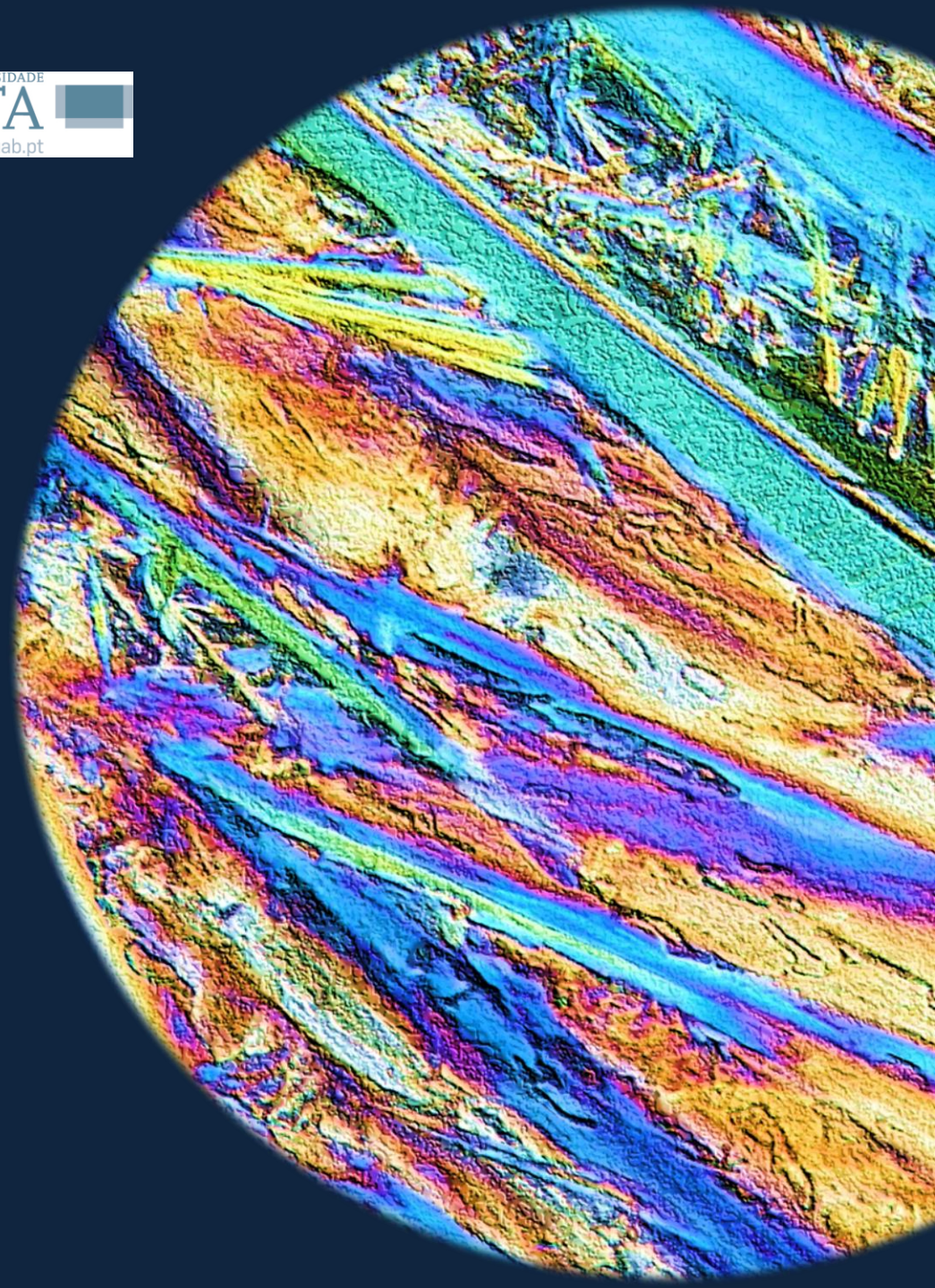


Seeking new low temperature energy storage systems: *n*-alkanes as phase change materials

16º Encontro Nacional de Química Física; 17 a 19/07/2024;
Faculdade de Ciências da Universidade de Lisboa

**Maria C.M. Sequeira, Bernardo A. Nogueira, Timur Nikitin, Fernando J.P. Caetano,
Hermínio P. Diogo, João M.N.A. Fareleira, Rui Fausto**

16º Encontro Nacional de Química Física
17 a 19/07/2024 Faculdade de Ciências da Universidade de Lisboa



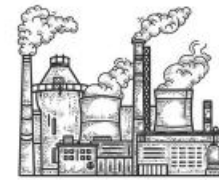
Introduction and Purpose



Thermal Energy Storage (TES)



Phase Change Materials (PCMs)



Industry

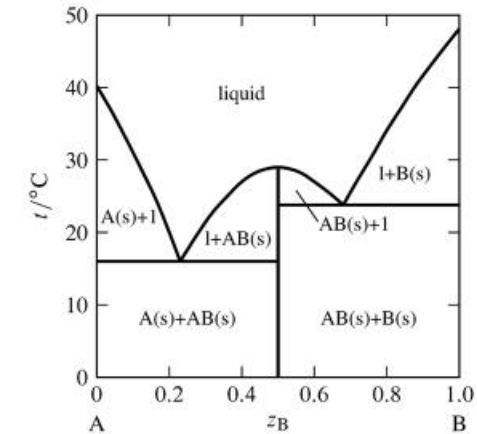


Medicines



Food

16º Encontro Nacional de Química Física: 17 a 19/07/2024
Faculdade de Ciências da Universidade de Lisboa



Phase Equilibrium Studies

1

2

3

4

Experimental Methods

**01. Differential Scanning
Calorimetry**

**02. Hot Stage
Microscopy**

03. Raman Spectroscopy

16º Encontro Nacional de Química Física; 17 a 19/07/2024;
Faculdade de Ciências da Universidade de Lisboa

1

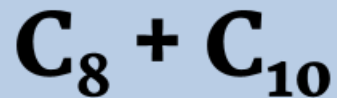
2

3

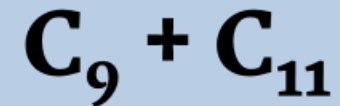
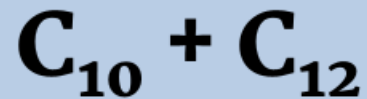
4

Experimental Results

Binary systems:



16º Encontro Nacional de Química Física; 17 a 19/07/2024;
Faculdade de Ciências da Universidade de Lisboa



Published in the International Journal of Thermophysics
DOI: 10.1007/s10765-023-03317-9

Accepted for publication in the
International Journal of
Thermophysics

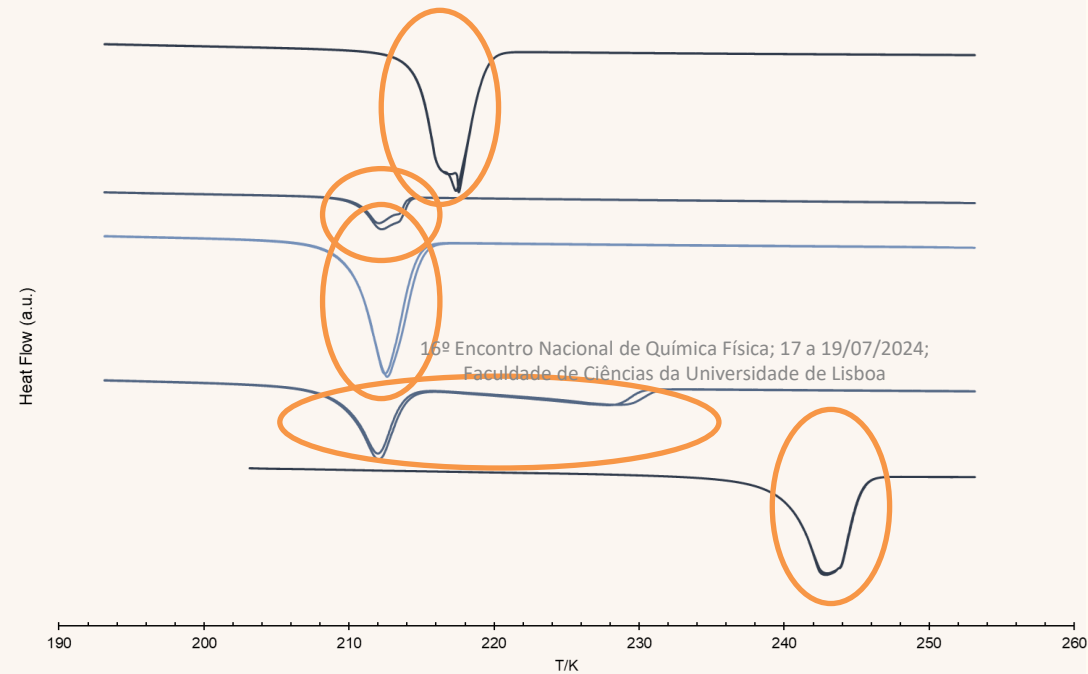


Fig.1a – DSC results of pure *n*-octane and *n*-decane and some of their binary mixtures.

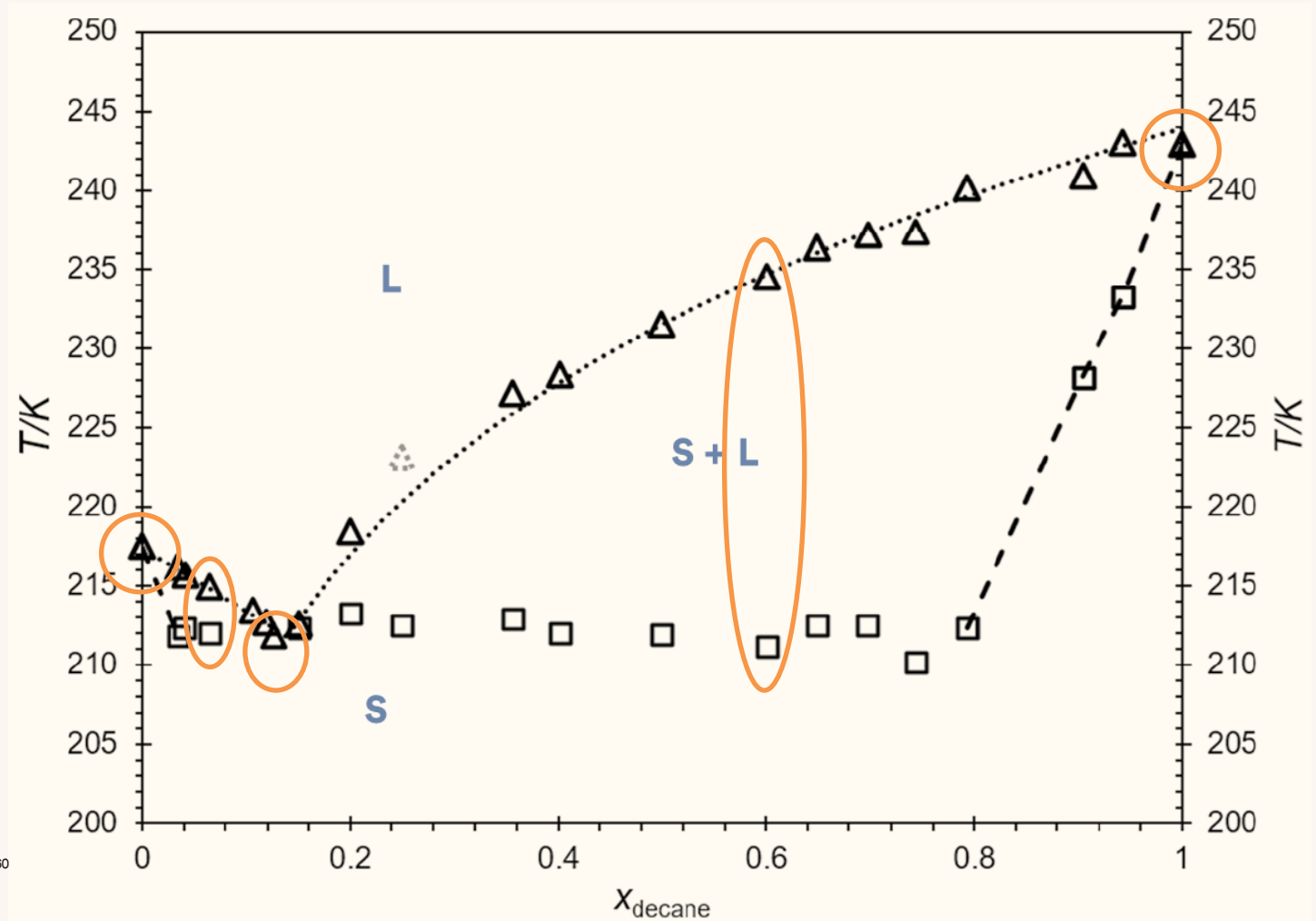


Fig.1 – Binary solid-liquid phase diagram of *n*-octane and *n*-decane.

1

2

3

4

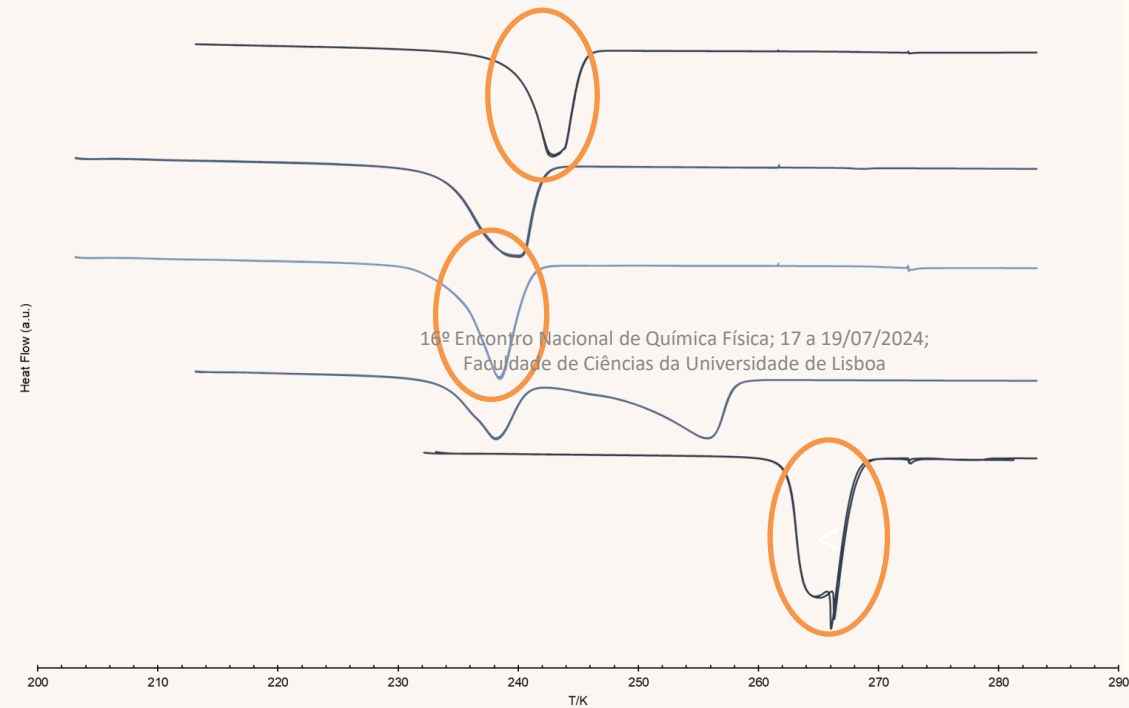


Fig.2a – DSC results of pure *n*-decane and *n*-dodecane and some of their binary mixtures.

16º Encontro Nacional de Química Física

17 a 19/07/2024 Faculdade de Ciências da Universidade de Lisboa

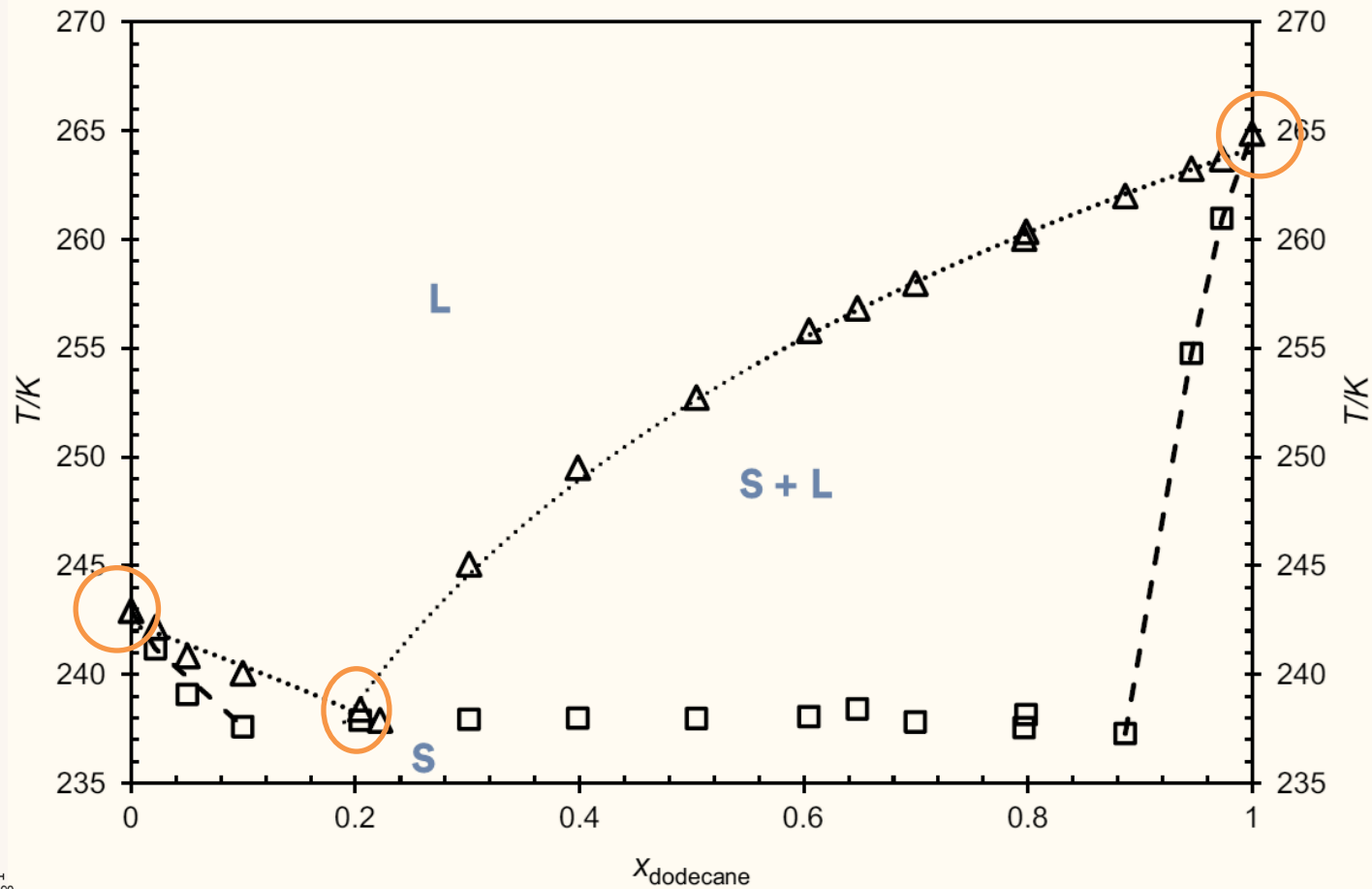


Fig. 2 – Binary solid-liquid phase diagram of *n*-decane and *n*-dodecane.

1

2

3

4

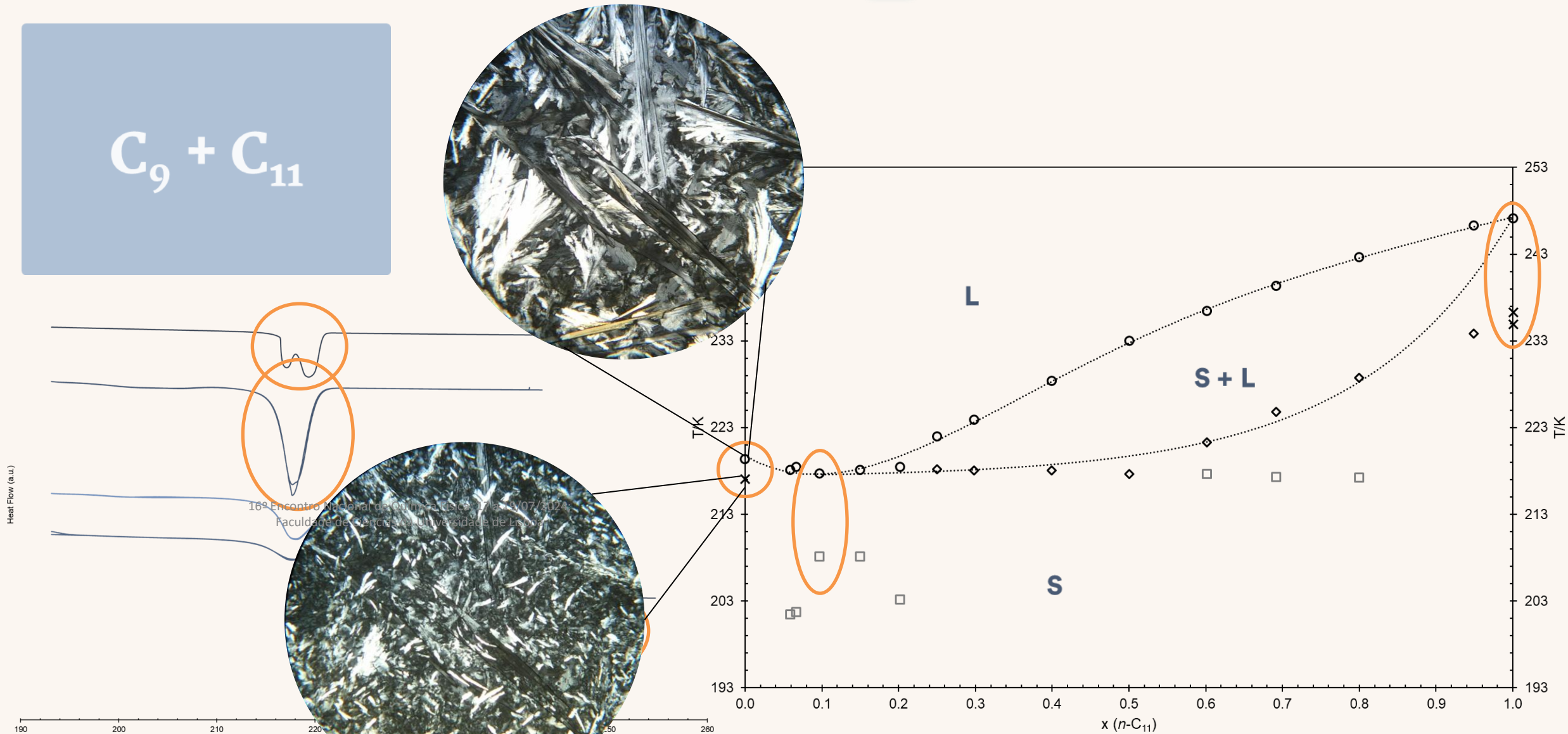


Fig.3a – DSC results of pure *n*-nonane and *n*-undecane and some of their binary mixtures.

Fig. 3 – Binary solid-liquid phase diagram of *n*-nonane and *n*-undecane.

Raman Spectroscopy

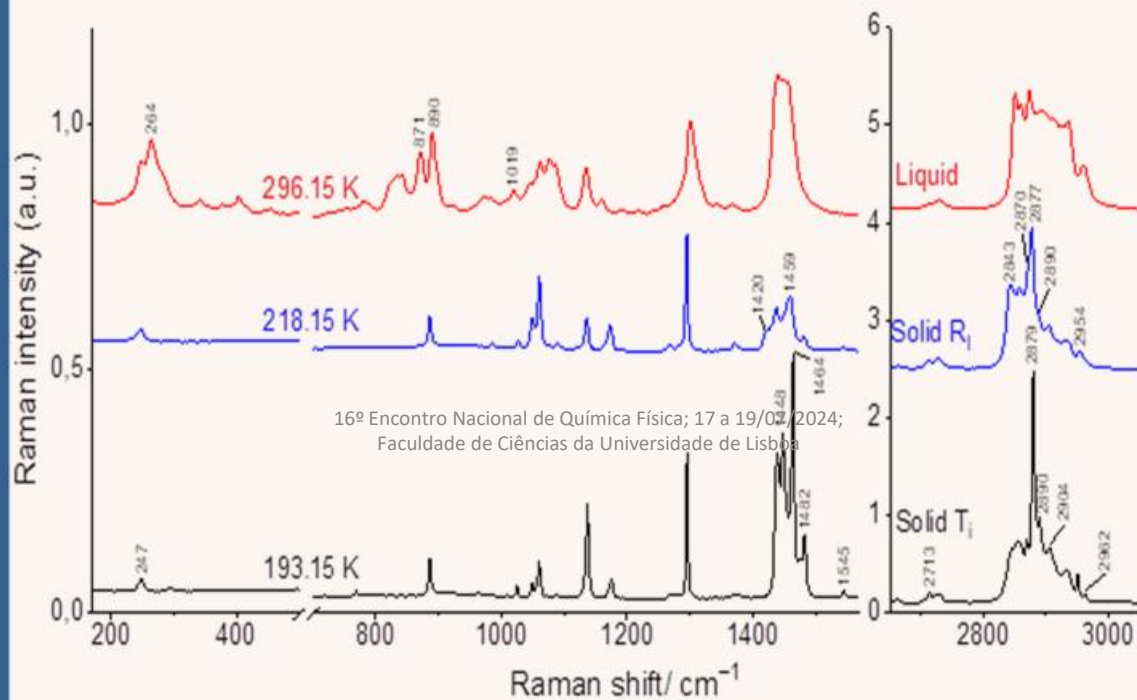


Fig. 4 – Raman spectra of solid and liquid phases of pure $n\text{-C}_9$.

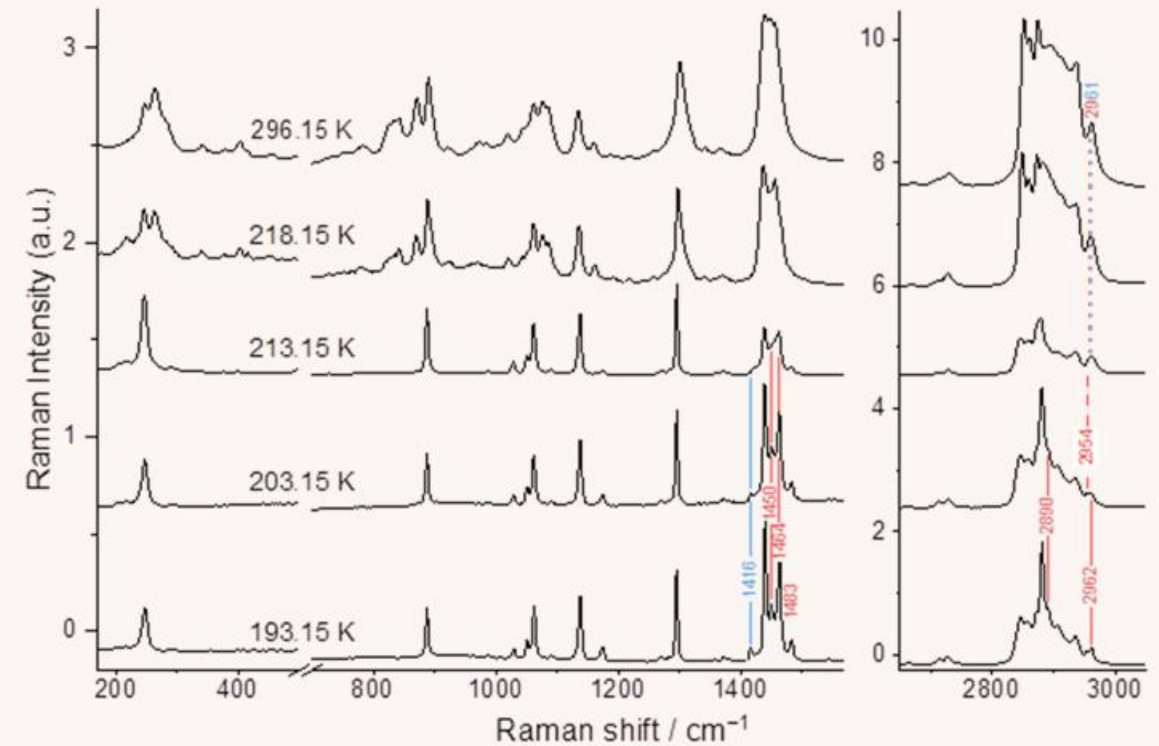


Fig. 5 – Temperature-variation Raman spectra for the eutectic mixture of the C_8/C_{10} binary system.

$T/^\circ\text{C}$

$\Delta_{fus}H/\text{J}\cdot\text{g}^{-1}$

$\text{C}_{10} + \text{C}_{12}$
-35

$\text{C}_8 + \text{C}_{10}$
139

$\text{C}_{10} + \text{C}_{12}$
137

$\text{C}_9 + \text{C}_{11}$
-57

$\text{C}_9 + \text{C}_{11}$
104

$\text{C}_8 + \text{C}_{10}$
-61

16º Encontro Nacional de Química Física; 17 a 19/07/2024;
Faculdade de Ciências da Universidade de Lisboa

Different Melting Points



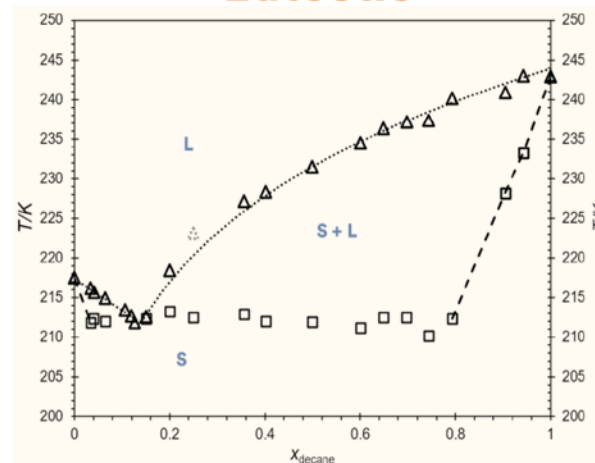
Different Applications

Similar Enthalpies of Fusion

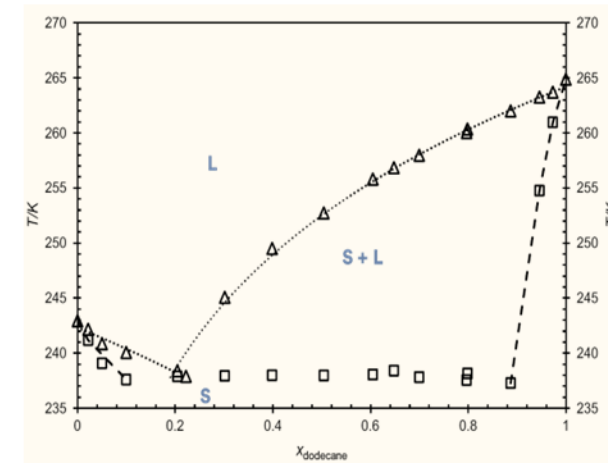


Similar Energy Storage Density

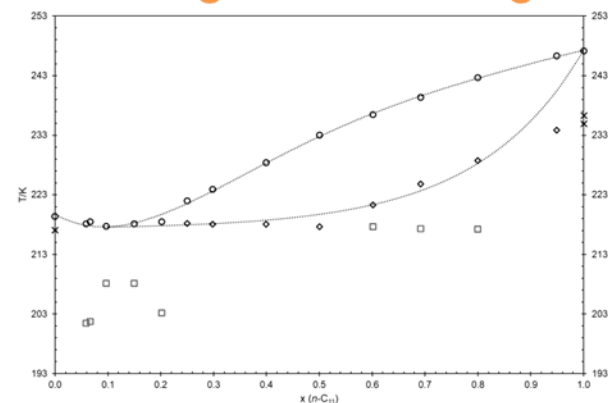
$\text{C}_8 + \text{C}_{10}$
Even + Even
Eutectic



$\text{C}_{10} + \text{C}_{12}$
Even + Even
Eutectic



$\text{C}_9 + \text{C}_{11}$
Odd + Odd
Congruent Melting



1

2

3

4

Conclusions and Future Work

01. Phase equilibrium studies for 3 different *n*-alkane systems

16º Encontro Nacional de Química Física; 17 a 19/07/2024;
Faculdade de Ciências da Universidade de Lisboa

02. DSC, HSM and Raman spectroscopy were used

03. Different solid-liquid phase equilibrium behaviour

04. Good potential as PCMs for low T applications

05. *n*-C₉ + *n*-C₁₀ system is being studied

06. Measurement of thermophysical properties

