

P009 Polymorphism in 4'-Hydroxyacetophenone: The full Picture from 0 K to Fusion

C. E. S. Bernardes¹, P. L. T. Melo¹, D. Yu. Ilin², V. A. Lukyanova², A. I. Druzhinina², M. E. M. da Piedade¹

¹ Centro de Química e Bioquímica and Centro de Química Estrutural, Faculdade de Ciências, Universidade de Lisboa, 1749-016 Lisboa, Portugal.

² Moscow State University, Department of Chemistry, 119991 Moscow, Russia.

4'-Hydroxyacetophenone (HAP, Figure 1a) has, in the last decade, emerged in our group as an excellent model to investigate diverse aspects of polymorphism and crystallization. Two polymorphs and three hydrates have been identified up to now, and characterized from structural, stability domains, solid state transitions and crystallization points of view.[1-6] Solubility studies demonstrated that the two polymorphs (Form I, monoclinic, $P2_1/c$, $Z' = 1$ and Form II, orthorhombic, $P212121$, $Z' = 2$) are enantiotropically related by a solid-solid phase transition at 303 K, where packing, molecular conformation, and Z' simultaneously change. Reversible interconversion of both forms at that temperature only occurs, however, under slurry conditions. Indeed, due to high kinetic barriers [5], the Form II→Form I transition can only be detected in the solid state, if the sample is heated to temperatures significantly above 303 K (i.e. metastable zone widths of 30-60 K, depending on the heating rate) and the reverse process has never been observed. Capitalizing on this irreversible behaviour, we used adiabatic calorimetry and molecular dynamics (MD) simulations to investigate the thermal behaviour of both HAP polymorphs down to 5 K. The adiabatic calorimetry experiments revealed the existence of a previously unknown fast and reversible enantiotropic phase transition, present in both polymorphs at 79 K (Figure 1b). The MD results showed no evidence of modifications in the crystal packing upon the transition (further confirmed by companion neutron diffraction analysis), [7] and also indicated that the observed thermal events are most likely related to the rotational freedom of the methyl group, which changes from a locked to a hindered-rotation regime. The full thermal behaviour and thermodynamic properties of both HAP polymorphs from 0 K to the fusion temperature will also be presented.

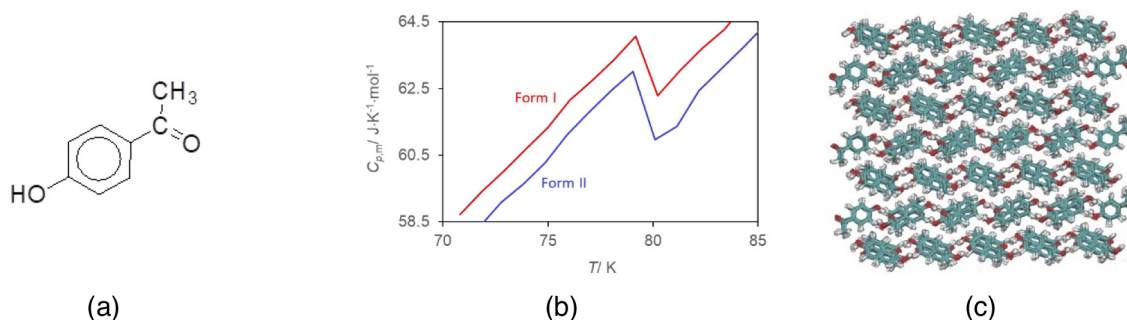


Figure 1: (a) 4'-hydroxyacetophenone (HAP); (b) Heat capacity curves obtained for forms I and II HAP by adiabatic calorimetry in the phase transition; (c) A snapshot from the MD simulations on Form I.

References

- [1] C. E. S. Bernardes, M. F. M. Piedade, M. E. Minas da Piedade; *Cryst. Growth Des.* 2008, 8, 2419.
- [2] C. E. S. Bernardes, M. F. M. Piedade, M. E. Minas da Piedade; *Cryst. Growth Des.* 2010, 10, 3070.
- [3] C. E. S. Bernardes, M. E. Minas da Piedade; *Cryst. Growth Des.* 2012, 12, 2932.
- [4] (a) C. E. S. Bernardes, M. L. S. Matos Lopes; J. R. Ascenso, M. E. Minas da Piedade; *Cryst. Growth Des.* 2014, 14, 5436; (b) C. E. S. Bernardes, L. Ilharco, M. E. Minas da Piedade; *J. Mol. Struct.* 2014, 1078, 181.
- [5] A. Joseph, C. E. S. Bernardes, A. I. Druzhinina, R. M. Varushchenko, T. Y. Nguyen, F. Emmerling, L. N. Yuan, V. Dupray, G. Coquerel, M. E. Minas da Piedade; *Cryst. Growth Des.* 2017, 17, 1918.
- [6] M. Gutmann, C. E. S. Bernardes, M. E. Minas da Piedade, unpublished.