Supporting information

Appendix A.

For conformations **3** and **4**, additional conformational MP2/6-311G(d,p) scans have been achieved around the equilibrium position of these two conformations. Six steps of 10° have been considered around the exact position of minima obtained with PBE0/6-31G(d,p) for conformation **3** and **4**. Each scan is accomplished with one dihedral angles constrained (either T1 or T2) and the rest of the molecule unconstrained. All the scans were performed in both directions (by steps of + 10° and -10°). As seen on the evolution in the figure, there is no discrepancy between the two series of points in each original (black squares) and reverse scans (red crosses) but they were accomplished on a limited range of dihedral angle values, in contrast with the potential energy surface scan in [Price, 2005]. According to the minimal dihedral angles values highlighted here, there is a little correction to bring about the position of the two minima in conformation **3** and **4** (60° in place of 70° for T2 in conformation **3** and 90° and 300° in place of 80° and 290° for T1 and T2 respectively in conformation **4**).

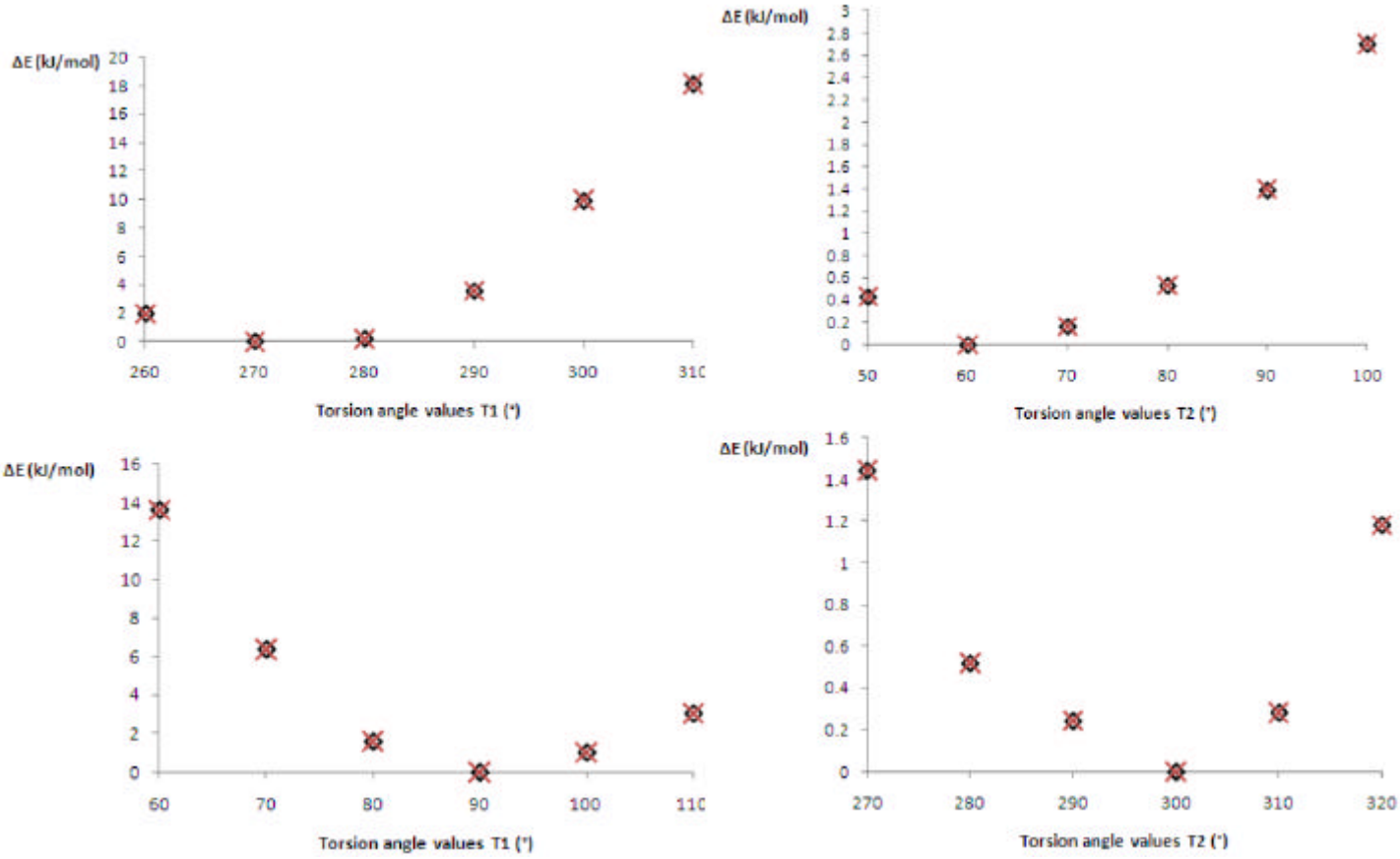

Figure Potential energy surface scans of T1 (left panels) and T2 (right panels) for PIRACETAM in conformation **3** (above) and **4**(under) in both directions for each scan

Appendix B.

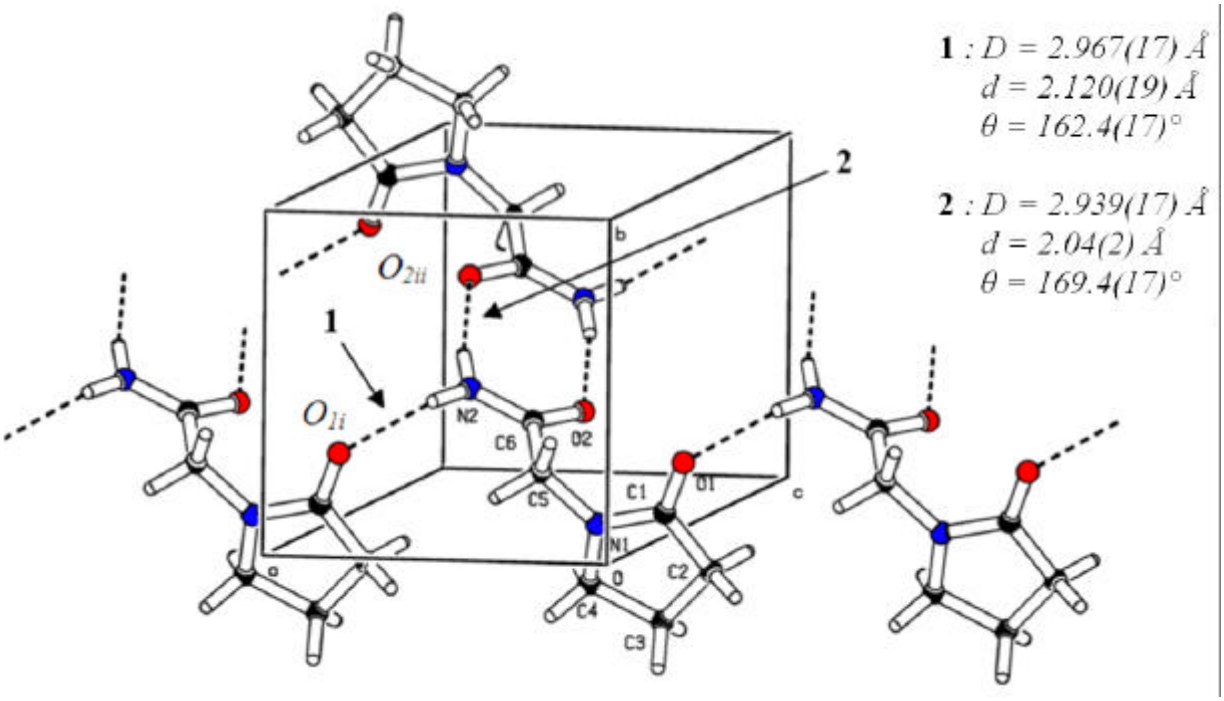

Figure H-bond network in the crystal packing for the experimental structure (Polymorph III) (D: distance between H-donor and H-acceptor atom; d: distance between H atom and H-acceptor atom and ?: angle between H-donor atom, H atom and H-acceptor atom) (i = x, y, – 1 + z ; ii = 1 – x, 1 – y, – z).

Appendix C.

Table Description of H-bonds for the five PIRACETAM polymorphs registered in CSD (D: distance between H-donor and H-acceptor atom; d: distance between H atom and H-acceptor atom and ?: angle between H-donor atom, H atom and H-acceptor atom) and comparison between form III from CSD and form III from this work.

Polymorph	**H-bond protagonists**	**D (?)**	**d (?)**	**? (°)**
*Form I (BISMEV03 [*Louër *et al.*, 1995*])* Space group : $P2_1/n$	NH_2 exo – $C=O_{1i}$ *endo* (**1**)	2.929(17)	2.005	148
	NH_2 exo – $C=O_{2ii}$ *exo* (**2**)	2.894(12)	2.123	122
(i = - ½ – x, - ½ + y, ½ – z, ii= - ½ + x, ½ – y, – ½ + z)				
*Form II (BISMEV [*Admiraal *et al.*, 1982*])* Space group : P-1	NH_2 exo – $C=O_{1i}$ *endo* (**1**)	2.9628	2.001	160
	NH_2 exo – $C=O_{2ii}$ *exo* (**2**)	2.9419	1.954	169
(i = 1 – x, 1 – y, – z, ii= 1 + x, y, z)				
*Form III (BISMEV02 [*Galdecki *et al.*, 1983*])* Space group : $P2_1/n$	NH_2 exo – $C=O_{1i}$ *endo* (**1**)	2.964(6)	2.161(3)	160.6(3)
	NH_2 exo – $C=O_{2ii}$ *exo* (**2**)	2.939(6)	2.053(3)	167.7(2)
(i = x, y, – 1 + z ; ii = 1 – x, 1 – y, – z)				
*Form IV (BISMEV04 [*Fabbiani *et al.*, 2005*])* Space group : $P2_1/c$	NH_2 exo – $C=O_{1i}$ *endo* (**1**)	3.017(5)	2.173	162
	NH_2 exo – $C=O_{2ii}$ *exo* (**2**)	2.941(8)	2.050	176
(i = 2 – x, - ½ + y, 5/2 – z, ii= 1 – x, – y, 2 – z)				
*Form V (BISMEV08 [*Fabbiani *et al.*, 2007*])* Space group : P-1	NH_2 exo – $C=O_{1i}$ *endo* (**1**)	2.953(10)	2.140	153
	NH_2 exo – $C=O_{2ii}$ *exo* (**2**)	2.881(11)	2.017	167
(i = - 1 + x, y, z; ii = 1 - x, - y, - z)				

Appendix D.

Table General description of the 30 structures in CSD involving PIRACETAM.

CSD Refcode	Cocrystallizer	Space group	R_1-factor (%)	[Reference, Deposition year]	T1 (°)	T2 (°)
BISMEV03 (Polymorph I)	/	$P2_1/n$	3.0	[Louër *et al.*, 1995]	103.3(14) **(*)**	178.4(11) **(*)**
BISMEV05 (Polymorph I)	/	$P2_1/n$	4.2	[Fabbiani *et al.*, 2005]	95.6(16) **(*)**	177.5(19) **(*)**
BISMEV (Polymorph II)	/	P-1	5.8	[Admiraal *et al.*, 1982]	91.9 **(*)**	155.1 **(*)**
BISMEV01 (Polymorph III)	/	$P2_1/n$	6.4	[Admiraal *et al.*, 1982]	92.7 **(*)**	159.2 **(*)**
BISMEV02 (Polymorph III)	/	$P2_1/n$	4.9	[Galdecki *et al.*, 1983]	92.6(2) **(*)**	200.63(2) **(*)**
BISMEV04 (Polymorph IV)	/	$P2_1/c$	5.3	[Louër *et al.*, 1995]	115.4(6) **(*)**	328.0(7) **(**)**
BISMEV06 (Polymorph V)	/	P-1	11.5	[Fabbiani *et al.*, 2007]	89.6(12) **(*)**	154.1(9) **(*)**
BISMEV07 (polymorph V)	/	P-1	8.8	[Fabbiani *et al.*, 2007]	90.4(13) **(*)**	158.8(8) **(*)**
BISMEV08 (polymorph V)	/	P-1	8.0	[Fabbiani *et al.*, 2007]	91.2(10) **(*)**	160.3(7) **(*)**
BISMEV09 (polymorph V)	/	P-1	8.8	[Fabbiani *et al.*, 2007]	86.8(12) **(*)**	159.7(8) **(*)**
BISMEV10 (polymorph V)	/	P-1	9.1	[Fabbiani *et al.*, 2007]	84.5(13) **(*)**	160.6(8) **(*)**
YAKWAJ (monohydrate)	/	P-1	4.1	[Fabbiani *et al.*, 2005]	92.2(11) **(*)**	170.43(10) **(*)**
LIFNOE (dihydrate)	/	P-1	3.5	[Fabbiani *et al.*, 2007]	118.0(5) **(*)**	153.0(5) **(*)**
Polymorph III	/	$P2_1/n$	3.5	In this work	93.00(13) **(*)**	159.25(11) **(*)**
DAVPAS	Gentisic acid	C2/c	4.3	[Vishweshwar *et al.*, 2005]	76.7(9) **(*)**	185.7(7) **(*)**
DAVPEW	Parahydroxybenzoïc acid	$P2_1/n$	4.8	[Vishweshwar *et al.*, 2005]	80.7(11) **(*)**	168.4(3) **(*)**
RUCDUP	L-tartaric acid	$P2_12_12_1$	3.4	2009 [Viertelhaus *et al.*, 2009]	258.0(13) **(*)**	199.3(10) **(*)**
RUCFAX	Citric acid (1 : 1)	$P2_1/a$	3.5	[Viertelhaus	114.8(17)	159.8(14)

				et al., 2009]	**(*)**	**(*)**
RUCFEB	Citric acid (3 : 2)	$P2_1/a$	7.7	[Viertelhaus *et al.*, 2009]	110.3(2) **(*)** 81.3(2) **(*)**	157.1(2) **(*)** 183.4(2) **(*)**
RUCFIF	Mandelic acid (racemic)	C2/c	8.3	[Viertelhaus *et al.*, 2009]	72.2(2) **(*)** 87.5(19) **(*)**	161.0(2) **(*)** 178.4(13) **(*)**
XOZSOV	L-mandelic acid	$P2_12_12_1$	5.5	[Viertelhaus *et al.*, 2009]	281.4(2) **(**)** 265.9(2) **(**)**	176.2(17) **(*)** 189.5(17) **(*)**
YEDJIA	Cobalt (Co (II))/ 2 NO_3^- / $2H_2O$	P-1	3.9	1993 [Sabirov *et al.*, 1993*a*]	107.7(4) **(*)**	169.6(3) **(*)**
HAFSAI	Cobalt (Co (II))/ 2 Cl^- / $2H_2O$	P-1	3.3	1992 [Sabirov *et al.*, 1992*c*]	104.5(3) **(*)**	160.5(3) **(*)**
HEPWII	Copper (Cu (II))/ 2 NO_3^- / $2H_2O$	$P2_1/n$	7.5	1993 [Sabirov *et al.*, 1993*b*]	112.3(7) **(*)**	7.8(9) **(**)**
JOFJAP	Copper (Cu (II))/ $2H_2O$ / ClO_4^-	$P2_1/c$	6.7	1992 [Delacruz *et al.*, 1992]	90.7(4) **(*)**	9.3(7) **(**)**
WAJPAY	Copper (Cu (II))/ 2 NO_3^- / $2H_2O$	$P2_1/n$	2.9	1992 [Sabirov *et al.*, 1992*a*]	113.8(2) **(*)**	7.7(3) **(**)**
WAJSOP	Zinc (Zn (II))/ $2H_2O$	$P2_1/n$	4.7	1992 [Sabirov *et al.*, 1992*b*]	97.6(7) **(*)**	2.6(7) **(**)**
WEGBEP	Zinc (Zn (II))/ 2 NO_3^- / $2H_2O$	P-1	4.5	1993 [Sabirov *et al.*, 1993*c*]	104.8(4) **(*)**	167.8(3) **(*)**
LEDZUP	Manganese (Mn (II))/ 2 Cl^- / $2H_2O$	P-1	4.7	1993 [Sabirov *et al.*, 1993*d*]	99.6(18) **(**)**	159.8(17) **(*)**
HEPWUU	Nickel (Ni (II))/ 2 NO_3^- / $2H_2O$	P-1	4.7	1993 [Sabirov *et al.*, 1993*e*]	109.0(4) **(*)**	167.5(8) **(*)**
OHECEK	Nickel (Ni (II)) / 2 H_2O (With Cl^- & H_2O)	$P2_1/c$	6.9	[Braga *et al.*, 2009]	85.8(11) **(*)**	350.0(13) **(**)**
Dihedral angles distribution					*** Category 1 : 90 ± 30°** **** Category 2 : 270 ± 30°**	*** Category 1 : 180 ± 30°** **** Category 2 : 0 ± 30°**