

**m29.o01****Energy minimisation of crystal structures containing flexible molecules**

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This paper proposes a new methodology for the accurate minimisation of crystal structures containing flexible molecules. The intramolecular contributions to the lattice energy are calculated from ab initio calculations and appear well balanced with the intermolecular interactions being evaluated via a conformation-dependent distributed multipole model [1] in conjunction with an empirical repulsion-dispersion potential model. The validity of the methodology is tested by minimising the experimental crystal structures of a set of flexible molecules. The reproduction quality is significantly improved compared with earlier studies, where the use of empirical intramolecular potentials often led to excessive distortions of the molecular geometry even when combined with realistic intermolecular potential models [2].

A stringent test is the reliable prediction of crystal structure without relying on experimental information. The methodology has been applied to the refinement of putative structures generated earlier with a rigid-body search methodology in the cases of the diastereomeric salt pair (R)-1-phenylethylammonium-(R,S)-2-phenylpropanoate [3] and the anti-epileptic drug carbamazepine [4]. The energy ranking of the known forms in the list of hypothetically generated structures is significantly improved, whilst their relative stability is in accord with experimental evidence.

[1] Stone, A. J.; Alderton, M. *Mol.Phys.* 1985, 56, 1047-1064.[2] Brodersen, S.; Wilke, S.; Leusen, F. J. J.; Engel, G. *Phys.Chem. Chem.Phys.* 2003, 5, 4923-4931.[3] Karamertzanis, P. G.; Price, S. L. *J.Phys.Chem.B* 2005, 109, 17134-17150.[4] Florence, A. J.; Johnston, A.; Price, S. L.; Nowell, H.; Kennedy, A. R.; Shankland, N. *J.Pharm.Sci.* 2006, accepted for publication.**m29.o02****Ab-initio quantum-mechanical investigation of molecular crystals**

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Molecular crystals are an important area of study in solid state chemistry. Structural, electronic, vibrational properties can now be easily computed at ab-initio level allowing the characterization of H-bonds, the analysis of the modifications in the electron charge density due to the formation of the crystal, calculation of structure factors.

Results on the investigation of simple hydrogen bonded molecular crystals (e.g. urea, formic acid) will be reported. All calculations were carried out by using a development version of the periodic ab initio code CRYSTAL [1] which performs full geometry optimization and vibrational frequency calculation at the  $\Gamma$  point. The dependence of structural, cohesive and vibrational properties on both adopted Hamiltonian (HF and DFT methods) and basis set will be discussed. Dispersive interactions, not properly taken into account by present DFT methods, are mandatory to obtain structures, cohesive energies and vibrational frequencies in agreement with experiments. Electron correlation responsible for dispersion energy can be included through a post-HF approach [2]. Preliminary results on simple molecular crystals (e.g. CO<sub>2</sub>, C<sub>2</sub>H<sub>2</sub>) obtained at the MP2 level of theory will be presented.

[1] Saunders V.R.; Dovesi R.; Roetti C.; Orlando R.; Zicovich-Wilson C.; Harrison N.H.; Doll K.; Civalleri B.; Bush I.J.; D'Arco Ph.; Llunell M.; *CRYSTAL03 user's manual*, University of Torino, Torino, 2003.[2] Pisani C.; Busso M.; Capecchi G.; Casassa S.; Dovesi R.; Maschio L.; Zicovich-Wilson C.M.; Schütz M., *J. Chem. Phys.* 2005, 112, 094113.