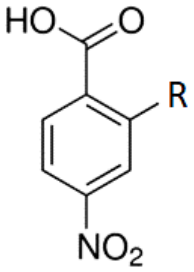
PREDICTION OF SOLID SOLUTION FORMATION AMONG CHEMICALLY SIMILAR MOLECULES USING CALCULATION OF LATTICE AND INTERMOLECULAR INTERACTION ENERGY

Kristaps Saršūns[a], Agris Bērziņš[a]

[a] Faculty of Chemistry, University of Latvia, Jelgavas street 1, Riga, Latvia
kristaps.sarsuns@lu.lv

Organic solids are able to form very wide range of crystalline structures of different compositions – including polymorphs, solvates, co-crystals and solid solutions (**SS**). In last decade, research of solid solutions has increased significantly and has become common in crystal engineering. While analysing solid solutions and their molecular packing, more attention is paid to structural aspects that promote and are responsible for the formation of solid solutions in two-component systems [1]. Both geometric and chemical aspects, such as molecule dimensions, symmetry, and intermolecular interactions, are important in understanding solid-state properties of all these phases [1, 2].

Several 2-substituted 4-nitrobenzoic acid (**NBA**) derivatives (**Fig.1**) were selected as model compounds because of their availability and chemically similar structures, in which the different group/atom (**R**) does not significantly affect the dominant intermolecular interactions [2].



R = halogen atom (-Cl), hydroxyl group (-OH) or methyl group (-CH_3)

Fig.1. Molecular structure of 2-substituted 4-nitrobenzoic acid

Quantum chemical calculations for lattice and intermolecular interaction energy were carried out to identify possible factors, which could be used in prediction of the formation of solid solutions in binary systems of chemically similar molecules, in this case - various nitrobenzoic acid derivatives [2, 3]. While crystallization experiments were used to determine the experimental information (**Table 1**) about formation of solid solutions. Obtained crystalline phases were characterized by combined use of powder X-ray diffraction (**PXRD**) and differential scanning calorimetry (**DSC**) [3].

Table 1. Experimentally obtained crystalline phases from different nitrobenzoic acid mixtures

Substance ratio / %	Series of nitrobenzoic acid derivatives		
	$2OH4NBA_{100-x}2C4NBA_x$	$2CH_34NBA_{100-x}2C4NBA_x$	$2OH4NBA_{100-x}2CH_34NBA_x$
0:100	$^{2C4NBA}I$	$^{2C4NBA}I$	$^{2CH34NBA}I$
10:90	**Mixture**	**Mixture**	$SS^{2CH34NBA}I$
25:75	**Mixture**	$SS^{2CH34NBA}I$	**Mixture**
30:70	$SS^{2OH4NBA}I$	$SS^{2CH34NBA}I$	**Mixture**
50:50	$SS^{2OH4NBA}I$	$SS^{2CH34NBA}I$	**Mixture**
70:30	$SS^{2OH4NBA}I$	$SS^{2CH34NBA}I$	$SS^{2OH4NBA}I$
75:25	$SS^{2OH4NBA}I$	$SS^{2CH34NBA}I$	$SS^{2OH4NBA}I$
90:10	$SS^{2OH4NBA}I$	$SS^{2CH34NBA}I$	$SS^{2OH4NBA}I$
100:0	$^{2OH4NBA}I$	$^{2CH34NBA}I$	$^{2OH4NBA}I$

2OH4NBA – 2-hydroxy-4-nitrobenzoic acid, 2C4NBA – 2-chloro-4-nitrobenzoic acid, $2CH_34NBA$ – 2-methyl-4-nitrobenzoic acid, I – polymorph, SS – solid solution.

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[1] Lusi, M. *Crystal Growth & Design*, **2018**, *18(6)*, 3704-3712.
[2] Corpinot, M. K., Guo, R., Tocher, D. A., Buanz, A. B. M., Gaisford, S., Price, S. L., Bučar, D. K. *Cryst. Growth Des.*, **2017**, *17*, 827−833.
[3] Romasanta, A. K. S., Braga, D., Duarte, M. T., Grepioni, F. *CrystEngComm.*, **2017**, *19*, 653-660.