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Probing the Surface Properties of Solid Lipid Nanoparticles by Atomic Force Microscopy

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Development of drug delivery systems is an indispensable strategy for successful transport of drug to its therapeutic site by the appropriate choice of carrier and route. Solid lipid nanoparticles (SLN) include the advantages of conventional carriers and are additionally utilized for protection of labile compounds, as well as in controlling of drug release, targeting and stability.

In general, physicochemical characteristics of SLN surface are those, which affect their behaviour both in vivo and in vitro [1, 2]. Consequently, development of appropriate design technique is crucial to effectively estimate the potential offered by SLN. The main objects of current research were to evaluate nanoparticles morphology (size, distribution, shape, structure, integrity), and their nano-mechanical properties such as adhesion forces and local hardness. Atomic force microscopy (AFM) has been used for these studies. More precisely, phase imaging as an extension of the tapping mode AFM, provided the mapping of the surface properties variations, such as composition, adhesion, friction and visco-elasticity.

SLN unlabelled and particles labelled with different coumarin based fluorescent dyes such as SPP 189 (SLN SPP-189) and 6-coumarine (SLN C), produced by melt-emulsification process were circular in shape. Photon correlation spectroscopy and AFM provided approximately the same particle size of investigated samples. Surface roughness of SLN SPP-189 was significantly elevated in comparison to unlabelled SLN, what should be the consequence of into surface incorporated fluorescent dye. Phase imaging and force spectroscopy measurement estimated the surface heterogeneity and local surface hardness. Phase contrast confirmed two different regions of SLN SPP- 189, which could be associated with surface heterogeneity caused by diverse nature of main constituents as well as fluorescent dye. Only these nanoparticles demonstrated light hallow in phase image, likely related to inhomogeneous distribution of lipophilic ingredients that also reflects differences in local surface hardness.

Current research will be additionally complemented with analysis of particles-cells interaction in order to improve the understanding of SLN composition involved in the cell uptake and in cell drug delivery.

[1] Kristl J, Teskač K, Milek M, Mlinarič-Raščan I. Surface active stabilizer Tyloxapol in colloidal dispersions exerts cytostatic effects and apoptotic dismissal of cells. Toxicol Appl Pharmacol. 2008; 232: 218–225. doi:10.1016/j.taap.2008.06.019.

[2] Teskač K, Kristl J. The evidence for solid lipid nanoparticles mediated cell uptake of resveratrol. Int J Pharm. 2010; 390: 61–69. doi:10.1016/j.ijpharm.2009.10.011