smartPearls™ - novel dermal delivery system for amorphous cosmetic and pharma actives

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Achieving a sufficient penetration and bioactivity of poorly soluble actives is a challenge in formulation technology. A simple but very efficient approach is the increase in saturation solubility Cs, thus increasing the concentration gradient Cs-Cs skin between formulation and skin, and subsequently the diffusional pressure. This can be achieved by transforming the active powder into the nanodimension, i.e. producing nanocrystals [1] (e.g. smartCrystals®). Alternatively the active can be transferred from the crystalline to the amorphous state, being even more efficient – but the amorphous state has physical stability problems excluding the dermal use. Ideal would be to combine the solubility enhancing effects of size reduction and amorphous state – this was realized in the smartPearls™ delivery system [2].

The delivery principle was previously employed for oral delivery [3] (CapsMorph®), and has now been transferred to dermal delivery. The cosmetic or pharma active is caged in the pores (typically 2–100 nm) of meso- or macroporous materials, e.g. silica (Syloid 3D, company Grace). The space restriction prevents re-crystallization, the amorphous state was proven stable up to 5 years [4]. The silica particles are loaded by the impregnation method or spray-drying, and the loaded silica particles simply dispersed in the water phase of gels or creams.

The anti-oxidants rutin and hesperdin as model actives were loaded onto Syloid® SP53D-11920 (SYLOID® 3D). These smartPearls™ were further studied in a porcine ear skin test to investigate the penetration behavior. The loading of active was 32.0% by using the wetness impregnation method. The amorphous state was verified for 6 months (until now) by x-ray diffraction (XRD). smartPearls™ were incorporated into a 5% hydroxypropyl cellulose (HPC) gel. The dermal formulations were physically stable by judging from microscopy (absence of silica particle aggregations) and XRD (no crystal peaks appeared).

smartPearls™ gels with only 1% active were applied to the pig ear tape stripping. Controls were 5% raw drug powder (RDP) gels and 5% nanocrystal (NC) gels. In absolute terms, the smartPearls™ formulation were slightly superior to nanocrystals, the difference became very clear after normalization of the data to 1% active content. Results were “normalized” dividing the drug amount (µg) per strip by the active concentration (%) in the applied formulation. Both
smartPearls™ formulations showed clear superiority.

The smartPearls™ technology stabilizes efficiently the amorphous state in porous materials, shows similar or even better dermal penetration than nanocrystals, is industrially feasible, and thus a promising dermal delivery technology for poorly soluble actives. The particle size of the smartPearls is typically 10-40 µm, thus outside the nano size range and no “nanoparticle” product. This is of increasing importance for the consumer due to the nanotoxicology discussions.

[1] C.M. Keck, Nanocrystals and amorphous nanoparticles and method for production of the same by a low energy process. US patent application 2013/0095198

