# Lipid sponge phases and nanoparticle dispersions able to entrap large biomolecules

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Nonlamellar lipid liquid crystalline phases have many potential applications, such as for drug delivery, protein encapsulation or crystallization.[1-4] Lipid liquid crystalline sponge phase ($L_3$) has not been very much considered in these applications, but have advantages in terms of its capacity of forming large aqueous pores able to encapsulate large bioactive molecules. This is more challenging to obtain with other reverse mesophases, such as reverse cubic ($Q_2$) and reverse hexagonal ($H_2$) phases. Basically, all of these reversed mesophases in excess aqueous solutions can be dispersed into colloidal stable particles dispersions.[1,5,6] Here, we report a novel lipid system able to form highly swollen $L_3$ phases, both in bulk and as nanoparticle dispersion. This system has been characterized by Dynamic Light Scattering (DLS), Cryo-Transmission Electron Microscopy (Cryo-TEM) and Small Angle X-ray Scattering (SAXS) to determine the size and shape of disperse particles as well as the liquid crystalline structure as a function of lipid composition. Water pores up to 13 nm were achieved, making the system suitable for entrapment of bioactive macromolecules such as proteins. Preliminary data on protein inclusion will also be presented.

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[1] X. Mulet, B. J Boyd and C. J. Drummond, *J. Colloid Interface Sci*. 2013, **393**, 1.
[2] J.Barauskas, C. Cervin, M. Jankunec, M. Spandyreva, K. Ribokaite, F. Tiberg and M. Johnsson, *Int. J. Pharm.* 2010, **391**, 284.
[3] M. Caffrey, *Curr. Opin. Struct. Biol.* 2000, **10**, 486.
[4] J. Barauskas, T. Nylander, In *Delivery and Controlled Release of Bioactives in Foods and Nutraceuticals*, 2008, **4**, pp 107–131, Woodhead Publishing Limited, Abington, England.
[5] M. Johnsson, Y. Lam, J. Barauskas and F. Tiberg, *Langmuir*, 2005, **21**, 5159.
[6] K. Larsson, *Curr. Opin. Colloid Interface Sci.,* 2000, **5**, 64.