Magnetic Liposomes for Biomedical Applications, Neutron Capture and Photodynamic X-ray Therapy : Neutron Scattering

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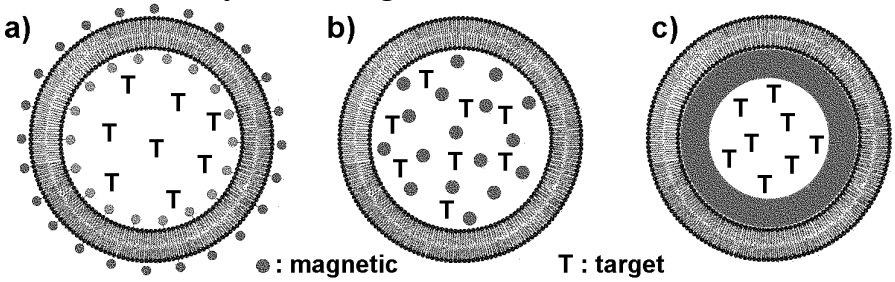
Liposomes are hollow nanoparticles from biogenic lipids, which can be used in biomedical applications because of their immunotolerance and bio-degradability. While simple liposomes entrapping target material in the inner volume have been used as drug carriers and early Boron Neutron capture therapy applications, problems occurred due to the low biological life time and the low local concentration (www.bnct.org). We have obtained a tremendous improvement of the method by introducing metals in the nanostructure [1-3, www.MPSD.de]:



As shown in fig.1, the magnetic metal compound was introduced in the metallo-liposomes by three methods: **a)** bound to the lipid layer as metal-head lipid, investigated at DESY-HASY-LAB-B1 and ESRF-ID1 [1]; **b)** entrapped in the lumen of the liposomes as soluble complex or sub-nanoparticles; or **c)** in magnetic shell liposomes bearing a lipid - metal oxide double layer shell, as extensively studied at ILL-D22 [2,3]. The structure and dynamics during synthesis was investigated by ASAXS, time resolved Neutron scattering TR-SANS and electron microscopy TR-EM with our stopped-flow technique [3, 4, www.MPSD.de].

If the metal is applied as a magnetic compound, the method results in magnetic liposomes, which can be magnetically dragged or concentrated selectively in the body area of interest, e.g. a tumor in cancer therapy or an imaging area. Further material can be co-entrapped for therapy, diagnostics or other analysis. We were successful in entrapping water-soluble target material in the lumen: organic compounds, metal chelates, Boric acid and (better) the Boron compounds BGB, BBG and BBT [3]. This enables the magnetic liposomes for magnetic imaging, neutron capture therapy (NCT with B, Gd, ^{7}Li), and photodynamic therapy with Synchroton radiation, with Gd or cis-Platinum, a source of Auger-electrons under irradiation. In both cases the magnetic liposomes with entrapped radiation target can supply a local radiotherapy with secondary radiation of very short range (< 30 µm), i.e. a few cell diameters.

[1] T. Nawroth, G.Gebhardt, K.Zwicker, G.Goerigk, DESY-HASYLAB Annual rep. I (2000).
[2] T. Nawroth, M. Rusp, R. P. May, a) ECNS 2003, proc. K40; b) Physica-B (2004) in press.
[3] T. Nawroth, R. P. May et al., ILL experiment reports (20003/04) 8-03-413, 9-10-661.
[4] M.Rössle, , T. Nawroth, T.Narayanan, H.Heumann et al., ESRF Newslett. **33**-10 (1999) 10