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Target Nanoparticles for Cancer Therapy : Structure Investigation by SAXS, SANS ASAXS, DLS and Electron Microsopy

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Cancer is one of the most urgent health problems in industrial countries: In the EU one of three people get cancer in their life, one of five die from the disease. The three most important methods of cancer treatment - surgery, radiation therapy and chemotherapy – decrease in effect by three for each level. The power of radiation therapy can be extended by indirect radiation therapy using heavy metal targets with synchrotron X-ray and neutron radiation. The healing effect of indirect radiation therapy, cell inactivation by secondary radiation products after beam absorption, is superimposed by unspecific radiation absorption, which may cause radiation damages. In our concept the ratio of healing to damaging effects is improved by the use of magnetic target nanoparticles that are based on two principles:

- **concentration** of about 1000,000 target atoms in nanoparticles of 100 nm size
- **local enrichment** of the nanoparticles by magnetic forces at the tumor site

We use two kinds of magnetic nanoparticles shown in the figure: **i) magnetic liposomes**, which bear the water soluble target in the entrapped lumen, and **ii) double shell poly-Ferrofluids**, containing the target in a surface layer by partial iron-lanthanide replacement.

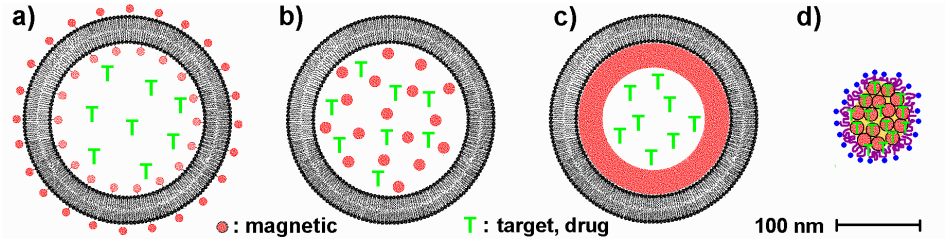

Figure 1: Target Nanoparticles for indirect radiation therapy can be enriched locally at the tumor site if the magnetic liposomes (a-c) or shell poly-Ferrofluids (d) are large (100 nm).

The magnetic target nanoparticles were investigated in structure by electron microscopy, dynamic light scattering DLS, neutron and synchrotron X-ray small angle scattering. The heavy metal target (Lu, Gd, Tm) was localized and quantified by ASAXS and XAS. The disc-structured poly-Ferrofluids and the magnetic liposomes exhibited a size of 100 nm. Micrometer-sized particles, which may cause embolism, were excluded by improved preparation techniques under feedback with DLS and small-angle scattering investigations. The growth of the magnetite/maghemite layer inside magnetic target liposomes was followed by time resolved SANS (stopped flow) [1]. The application of a magnetic gradient induced the reversible formation of magnetic superstructures (µm), as indicated by magnetic light scattering (M-DLS) and magnetic electron microscopy (M-EM).

References

[1] – T. Nawroth, M. Rusp and R.P. May, Physica **B 350**, e635-638 (2004) "Magnetic liposomes and entrapping : time resolved neutron scattering TR-SANS and electron microscopy"