Experimental report

17/11/2015

Proposal: 9-12-358 **Council:** 4/2014

Title: Small angle neutron scattering analysis of core-shell alkylated and fluorinated theranostic nanoparticles

Research area: Chemistry

This proposal is a new proposal

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Samples: Au nanoparticles
hydrophobin
fluorinated ligands

Instrument	Requested days	Allocated days	From	To
D11	1	1	14/12/2014	15/12/2014

Abstract:

The role of NPs as theranostic agents in the treatment and diagnosis of diseases is becoming increasingly important. The development and characterization of new nanoparticulate systems is crucial for the discovery of new potential therapies and imaging strategies. We have developed in our laboratory fluorinated core-shell gold nanoparticles that can simultaneously work as 19F MRI agents and drug delivery systems. Small angle neutron scattering (SANS) is a widely used technique for investigating nano-scaled systems as it allows a detailed structural characterization at the nanoscale. Here we propose a SANS study to determine the structure of different core-shell theranostic gold NPs.

Experiment N° 9-12-358 **Instrument** D11 **Dates** 14-12-2014

Small angle neutron scattering analysis of core-shell alkylated and fluorinated theranostic nanoparticles

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Introduction. In the last decades the use of nanoparticles (NPs) for biomedical applications has attracted a growing research interest, promoting NPs use in imaging, therapy, and drug delivery.[1] In this regard, supraparticles (SPs), obtained from NP assembly, have been shown to play a crucial role, thanks to their collective properties, in the technological and nanomedical fields.[2] The aim of this study was to elucidate the structural features of two kinds of SPs obtained from the hydrophobin II (HFBII) mediated assembly of gold NPs, stabilized by hydrogenated and fluorinated ligands, respectively.

Experimental. 1-Dodecanethiol (DT) stabilized NPs were synthesized according to the procedure reported by Lin et al. [3] 1*H*,1*H*,2*H*,2*H*-Perfluorodecanethiol (PFDT) stabilized NPs were prepared according to Dass et al.[4] Both DT and PFDT stabilized NPs were assembled into water-soluble SPs by the use of Hydrophobin II (HFBII), self-assembling amphiphilic protein. DT and PFDT SP samples dispersed in water and protein corona complexes of such SPs isolated from bovine serum were performed at three different detector distances (1.2, 8 and 40 m), in order to investigate SP features at different Q values. 1mm cells were employed.

Results and Discussion. Small angle neutron scattering spectra of DT (H-SP) and PFDT SPs (F-SP) are shown in Figure 1.

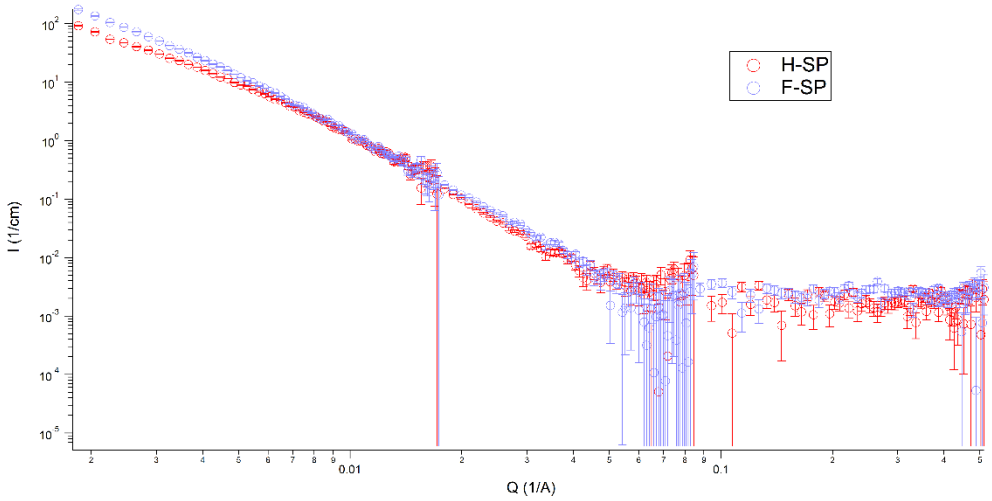

Figure 1: Comparison between Hydrogenated and fluorinated SPs SANS spectra

It can be seen that the scattering curves obtained for the hydrogenated and fluorinated SPs look similar and slight differences can only be observed at high-Q and low-Q values. The low-Q intensity appears higher for the fluorinated SPs that are indeed characterized by a higher hydrodynamic radius, while at high-Q a more bumpy baseline might indicate either a higher monodispersity of the fluorinated gold NPs or a more ordered structure of their assembly. We are currently developing a fitting analysis suited to resolve the SP structure that will hopefully shed light on these results .

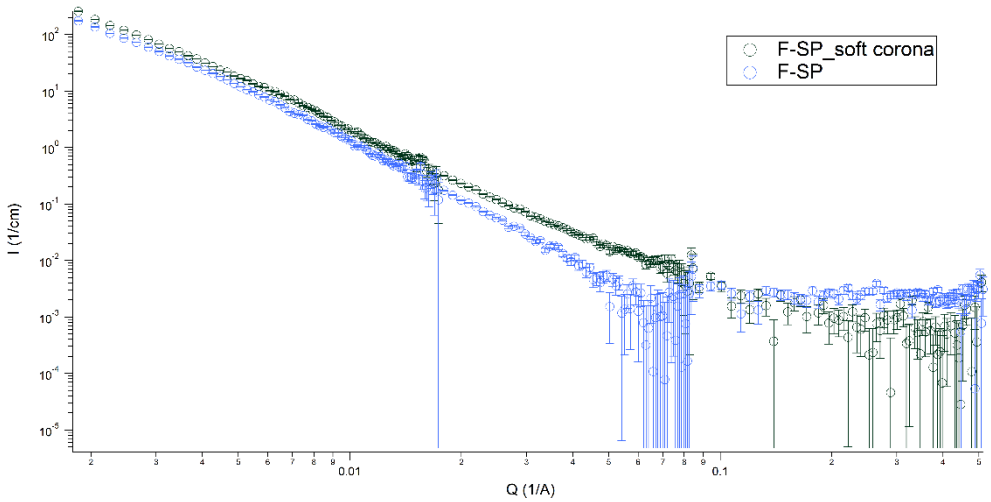

Figure 2: Comparison between F SPs scattering curve before and after soft corona formation

SANS measurements were also performed on both SPs after incubation in bovine serum. Protein corona complexes were isolated from excess of serum and measured at two different contrasts. Scattering curves in deuterated water are presented in Figure 2 and 3 for fluorinated and hydrogenated SPs. The general trend is very similar for both SPs, thus incubation in serum seems to induce the same effects. The overlap of the curves in the low-Q region indicates that the overall size and shape of the SPs is not affected by the incubation in serum, while differences are observed in the intermediate-high Q region. This might indicated that there are changes at the water-protein interface as expected. Also in this case a deeper analysis is needed.

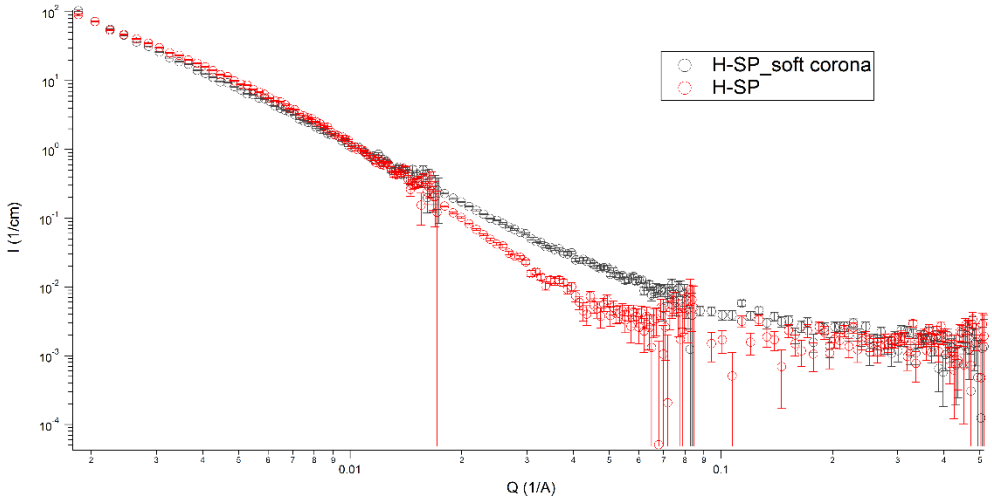

Figure 3: Comparison between H SPs scattering curve before and after soft corona formation

These preliminary results indicated that the protein corona pattern is similar for the two systems, despite the different ligands employed to stabilise the NPs. Therefore, it is likely that the corona formation is driven by the bovine serum protein interaction with hydrophobin, and is only poorly influenced by the ligand molecules that stabilise the NPs.

References

1. Doane, T.L. and C. Burda, Chemical Society Reviews, 41(7), 2885-2911 (2012).
2. Guo, et al, C. Adv. Mater. 25, 5196–214 (2013).
3. Lin, C.-A. J.,et al, Small, 4(3), 334–41 (2008).
4. Dass, A. et al (2008). *Langmuir*, *24* (1), 310–315 (2008).