Trimetallic nanocomposites serving as potential fluorescent and magnetic resonance imaging probes

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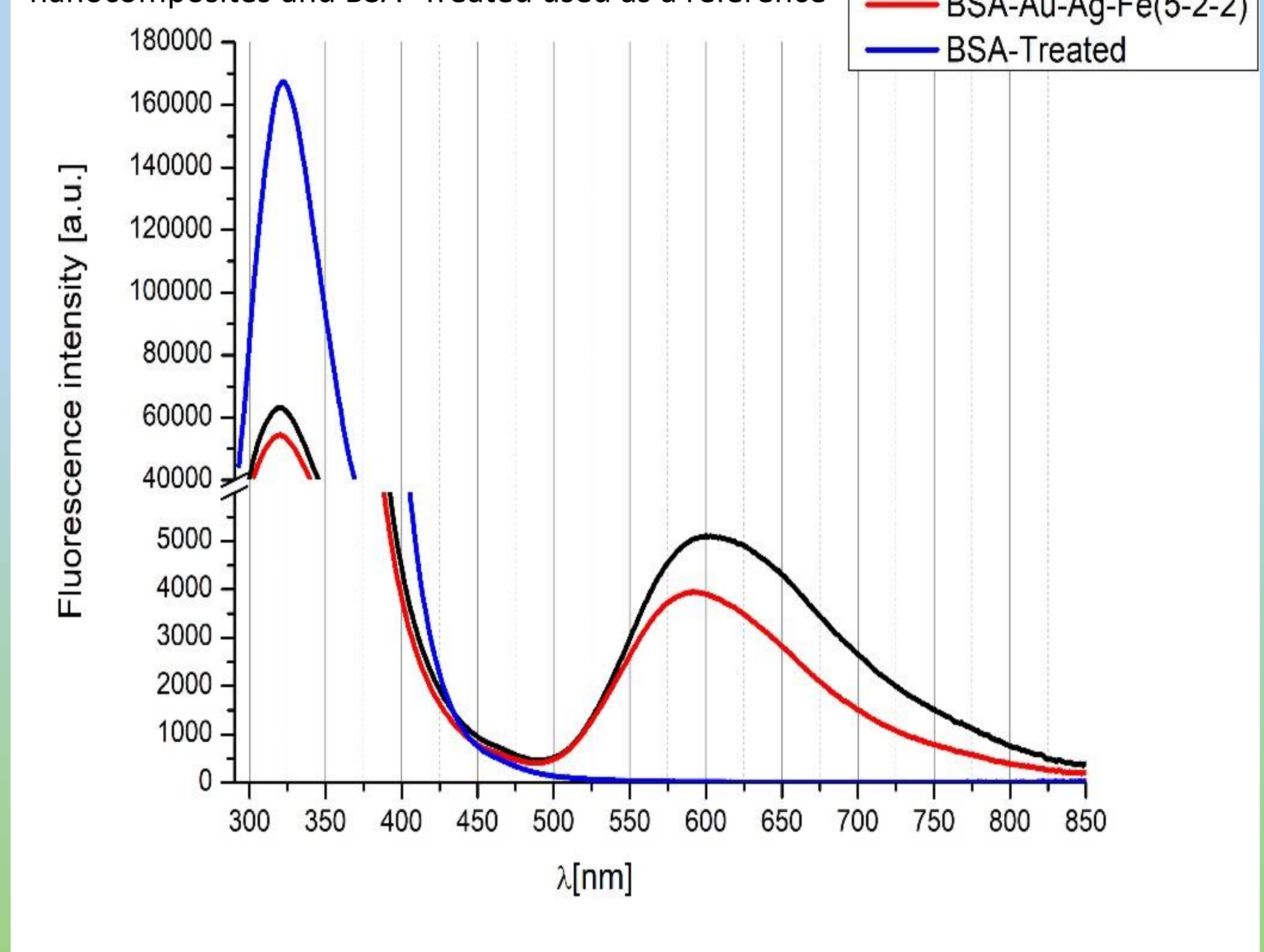
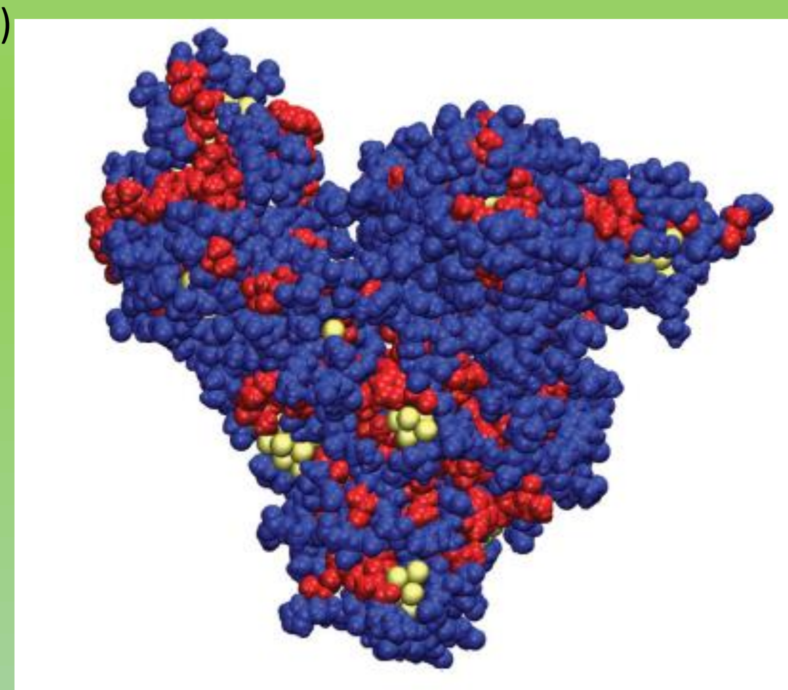
Abstract:
Novel fluorescent nanocomposites (NCs) were generated using ions of Au(III), Ag(I), Fe(II) in conjunction with bovine serum albumin (BSA). BSA served as a template and simultaneously as a reducing agent. Au(III) was selected for the formation of fluorescent AuNCs in the presence of BSA (1); Ag(I) was employed in order to enhanced fluorescence intensity of NCs (2); and Fe ions were chosen as precursors for the formation of a contrast agent being employed in ^{1}H magnetic resonance imaging (MRI) (3). Two molar ratios of Au and Ag ions used in the course of the synthesis of NCs substantially influenced NCs fluorescence intensity as well as the characteristic fluorescence peak position. On the other hand, it was revealed that Fe ions did not affect position of fluorescence peak maximum and had only a slightly negative effect on the fluorescence intensity of NCs with metal cations molar ratio of 5-1-1 and 5-2-2. At sufficiently elevated Fe ions concentrations, these novel NCs can be used for MRI without significant fluorescence signal quenching.

Fig. 1: Fluorescence spectra of trimetallic nanocomposites and BSA -Treated used as a reference



Outlook: Albeit nanocomposites of BSA and metal ions are extensively studied, the binding sites namely for Ag and Fe ions on protein and mechanisms of their interaction are not known in details. Further intensive research of trimetallic Au-Ag-Fe-BSA NCs is therefore necessary. Cytotoxicity of our NCs is another key issue to be determined before their potential *in vivo* usage.

Fig 2.: Hydrophobicity map of the BSA protein surface when gold has bonded to protein. Hydrophilic regions are represented by blue while hydrophobic regions are represented by red. Gold nanoclusters not fully buried under the surface (represented by yellow) – taken from ref. (4)



Main-take home message:
NCs containing three metals (Au, Ag, and Fe ions) capped with BSA can serve as fluorescent and MRI contrast probes. Their relaxivity (r_2 values) are comparable with commercially used contrast agents such as Magnevist and Dotarem.

Table 1.: Measurement of magnetic resonance imaging properties

	Sample	1x	2x	4x	5x
r_1 [L/mmol.s]	BSA-Au-Ag-Fe(5-1-1)	0.3	0.3	0.3	0.3
	BSA-Au-Ag-Fe(5-2-2)	0.1	0.6	0.2	0.2
r_2 [L/mmol.s]	BSA-Au-Ag-Fe(5-1-1)	2.4	2.6	2.8	3.1
	BSA-Au-Ag-Fe(5-2-2)	1.5	6.2	2.2	2.4

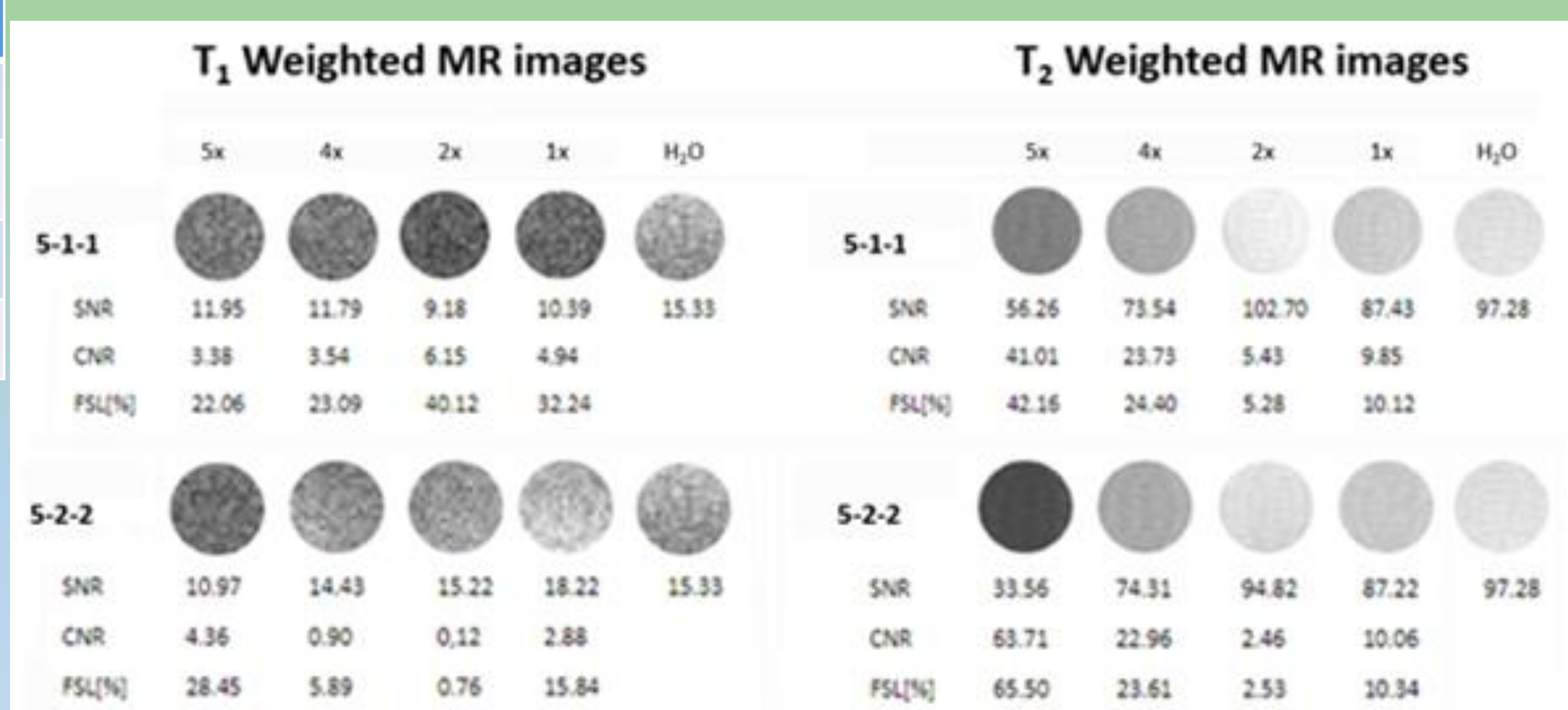


Figure 3: T_1 and T_2 weighted magnetic resonance (MR) images of samples **first row)** Au-Ag-Fe-BSA(5-1-1) 1x, 2x, 4x, 5x concentrated and **second row)** Au-Ag-Fe-BSA (5-2-2) 1x, 2x, 4x, 5x concentrated. SNR means signal to noise ratio, CNR represents contrast to noise ratio, FSL is fractional signal loss in percentage

Chemicals: HAuCl4; $AgNO_3$; $FeCl_2$; 98% BSA; all purchased from Sigma-Aldrich

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