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| RESEARCH ARTICLE

In-depth Literature Review of Functionalized Gold Nanoparticles for Detection of Metal Ions

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| ABSTRACT
Understanding the significance of metal ions in various environmental samples has achieved a keen interest by researchers. Because these metal ions have great impact on food chain, health, ecosystem and environment of agricultural, aqueous and industrial populations. Many analytical techniques are used for the detection of metal ions in biological, environmental, pharmaceutical and industrial samples. But in last few decades, Gold nanoparticles have attracted the research groups as they provide immediate visual results by showing instant color change in the presence of target analyte. In this review study we have focused on research articles that provide applications of gold nanoparticles, functionalized with different capping agents for detection of metal ions and enlisted wide list of metals ions and capping agents as well that show selectivity for specific metal ion.

| KEYWORDS
Functionalized Gold nanoparticles; Surface modification; Capping Agents; Binding Sites; Metal ions

| ARTICLE INFORMATION

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Introduction

Surface functionalization of gold nanoparticles with numerous capping agents has attracted extensive attention because such surface capped AuNPs improve sensing ability between receptor and target analytic to enhance the optical signals from their binding sites. Recently, significant efforts have been made by many research groups in developing novel synthetic approaches for making different sizes and shapes of AuNPs with various combinations of reducing and capping agents. Along with simple and extensively applicable synthetic methods, mono-dispersity and stability of AuNPs is desirable. Thus, preparation of gold nanoparticles by introducing new synthetic schemes has become one of the goals of material science. The surface modification of gold nanoparticles can easily be achieved by a variety of molecular recognition motifs (i.e. functional groups) and even mixtures of functional groups that provide affinity sites for the binding of target analytes [1]. The fascinating feature of this surface functionalization to materials synthesis is that one can have control over the size, shape, and arrangements of the specific nanoparticle building blocks. By virtue of which stability of AuNPs dispersions is enhanced that permits surfaces to be used as colorimetric sensors in sensing and imaging applications [2][3].

Literature Review

A list of capping agents having many binding sites showing selectivity for specific metal ion is mentioned below in Table:1. This list elaborates comparative approaches of capping agents towards gold nanoparticles and make their surfaces modified having new binding sites for target metal ions.

Table: 1.1

S.No:	Capping agent	Metal Ion	Reference
1.	β-cyclodextrin (β-CD)	Pb^{2+}	[4]
2.	Citrate (peptide)	Pd(II)	[5]
3.	Citrate (peptide)	Co(II)	[5]
4.	Citrate (peptide)	Pd(II)	[5]
5.	Citrate (DNA)	Hg(II)	[6]
6.	Borohydride,(dithiadiazo-2-[3-(2-aminoethylsulfanyl)propylsulfanyl]ethylamine)	Hg(II)	[7]
7.	Citrate (oligonucleotide)	Hg(II)	[8]
8.	Citrate (bovine serum albumin)	Pb(II)	[9]
9.	Citrate (DNA)	Cu(II)	[10]
10.	Citrate (calsequestrin)	Ca(II)	[11]
11.	Citrate (glutathione, dithiothreitol, and cysteine)	As(III)	[12]
12.	Citrate (pentapeptide)	Ag(I)	[13]
13.	Citrate (pentapeptide)	Al(III)	[14]
14.	Citrate (6-mercaptonicotinic acid and *L*-cysteine)	Cd(II)	[15]
15.	Bismuthiol II	Hg^{2+}	[16]
16.	GSH/DTT/Cys-modified gold nanoparticles	As(III)	[17]
17.	15-crown-5 Thiol	K^{+}	[18]
18.	Glutathione	Pb (II)	[19]
19.	Oligonucleotide 5′-TTT CTT CTT CGT TGT TGT TT-3′	Hg(II)	[20]
20.	Papain	Simultaneous Hg^{2+}, Pb^{2+} and Cu^{2+}	[21]
21.	Lapoic Acid	Pb^{2+}	[22]
22.	Casein peptide	Al^{3+}	[23]
23.	Guanidine thiocyanate	Cd^{2+}	[24]
24.	Diaminodiphenyl Sulfone	Simultaneous Al^{3+}, Fe^{3+}, Cr^{3+}	[25]
25.	Glutathione	Pb^{2+}	[26]
26.	*1) 2, 3-Pyridine dicarboxylic acid*	Cr^{3+}	[27]
27.	*2) Triazole*	Cr^{3+}	[28]
28.	*3) 5-thio-2-nitrobenzoic acid (TNBA) and horseradish peroxidase (HRP)*	Cr^{3+}	[29]
29.	*4) L-methionine (Met)*	Cr^{3+}	[30]

Conclusion

In this smart review study, data about applications of functionalized gold nanoparticles in the detection of metal ions, synthesized by many scholars in various research laboratories from different corners of the world are collected, compiled and organized in tabulated form.

Most of the metal ions that are detected by variety of functionalized gold nanoparticles are Al^{3+}, Fe^{3+}, Cr^{3+}, As^{3+}, K^{+}, Hg^{2+}, Pb^{2+} and Cu^{2+}, Ca^{2+}, Ag^{+}, Co^{2+}, Cd^{2+} and it is observed from the results shown in table that commonly and repeatedly detected metal ions are Pd^{2+}, Hg^{2+}, and As^{3+} as show selectivity towards many capping agents amongst all metal ions.

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