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RESEARCH ARTICLE

Au°-Nanoparticles: Control Size and Morphology Stabilized by Tripodal Phosphine Based Ligands and Their Antimicrobial Activity

Bibek Jyoti Borah[1], Archana Yadav[2], and Dipak Kumar Dutta[1]

[1] Materials Science and [2] Biotechnology Divisions,
North East Institute of Science and Technology (CSIR), Jorhat 785006, India

Metal nanoparticles have attracted great attention due to their potential applications in the fields like electronics, opto-electronics, bioscience, catalysis, etc. New ligands 1,1,1-tris (diphenylphosphinomethyl) ethane $[CH_3C(CH_2PPh_2)_3]$ 1 and 1,1,1-tris-(diphenylphosphino methyl) ethane trisulphide $[CH_3C(CH_2P(S)Ph_2)_3]$ 2 for stabilization of Au°-nanoparticles having small core diameter were prepared. The Au°-nanoparticles are more active against Gram(+) bacteria, e.g., *Staphylococcus aureus* than Gram(−) bacteria. Among the two Au°-nanoparticles, the ligand 1 stabilized particles shows higher activity.

Keywords: Au°-Nanoparticles, Antimicrobial Activity, Phosphine, Surface Plasmon, Single-Crystalline.

1. INTRODUCTION

Metal nanoparticles have attracted great attention due to their potential applications in the fields like electronics, opto-electronics, bioscience, catalysis, etc.[1–5] Ligands stabilized metal nanoparticles are considered as important building blocks. A numbers of phosphines and thiols stabilized metal nanoparticles were studied[6] but metal nanoparticles particularly Au°-nanoparticles stabilized by tripodal phosphines and its chalcogen functionalized have not been reported so far. We report new ligands 1,1,1-tris (diphenylphosphinomethyl) ethane $[CH_3C(CH_2PPh_2)_3]$ **1** and 1,1,1-tris-(diphenylphosphino methyl) ethane trisulphide $[CH_3C(CH_2P(S)Ph_2)_3]$ **2** for stabilization of Au°-nanoparticles having small core diameter and their antimicrobial activity against some Gram(+) and Gram(−) bacteria.

2. MATERIALS AND METHODS

$HAuCl_4 \cdot 3H_2O$, 1,1,1-tris (diphenylphosphino-methyl) ethane, elemental sulfur, Tetra-n-octylammoniumbromide and $NaBH_4$ were purchased from M/S Sigma Aldrich, USA. Phosphine stabilized Au°-nanoparticles were synthesized following the procedure of Hutchison et al.[5] The synthesized Au°-nanoparticles were characterized by UV-Visible spectroscopy, XRD, TEM and HRTEM, etc. techniques and evaluated for antimicrobial activity by standard Agar-well-diffusion method.

3. RESULTS AND DISCUSSION

The broad surface plasmon bands (Fig. 1(A)) of Au°-ligands (**1** and **2**) at around ∼520 nm indicate that the particles stabilized by ligand **1** are smaller than that of Au°-ligand **2**.[1]

The TEM images (not shown) for ligands **1** and **2** stabilized Au°-nanoparticles indicate narrow size distribution of 1.6 ± 0.4 nm and 3.0 ± 0.7 nm respectively. The HRTEM pattern (not shown) of Au°-nanoparticles stabilized by ligand **1** shows their single-crystalline nature.[7]

The XRD peaks of Au°-nanoparticles stabilized by ligand **1** could not be detected due to the small size (<2 nm),[1] while ligand **2** stabilized nanoparticles shows diffraction peaks (Fig. 1(B)) corresponding to the (111), (200), (220) and (311) surfaces of fcc gold, indicate the products are composed of crystalline gold.

The Au°-nanoparticles are more active against Gram(+) bacteria, e.g., *Staphylococcus aureus* than Gram(−) bacteria. Among the two Au°-nanoparticles, the ligand **1** stabilized one shows higher activity (Table I).

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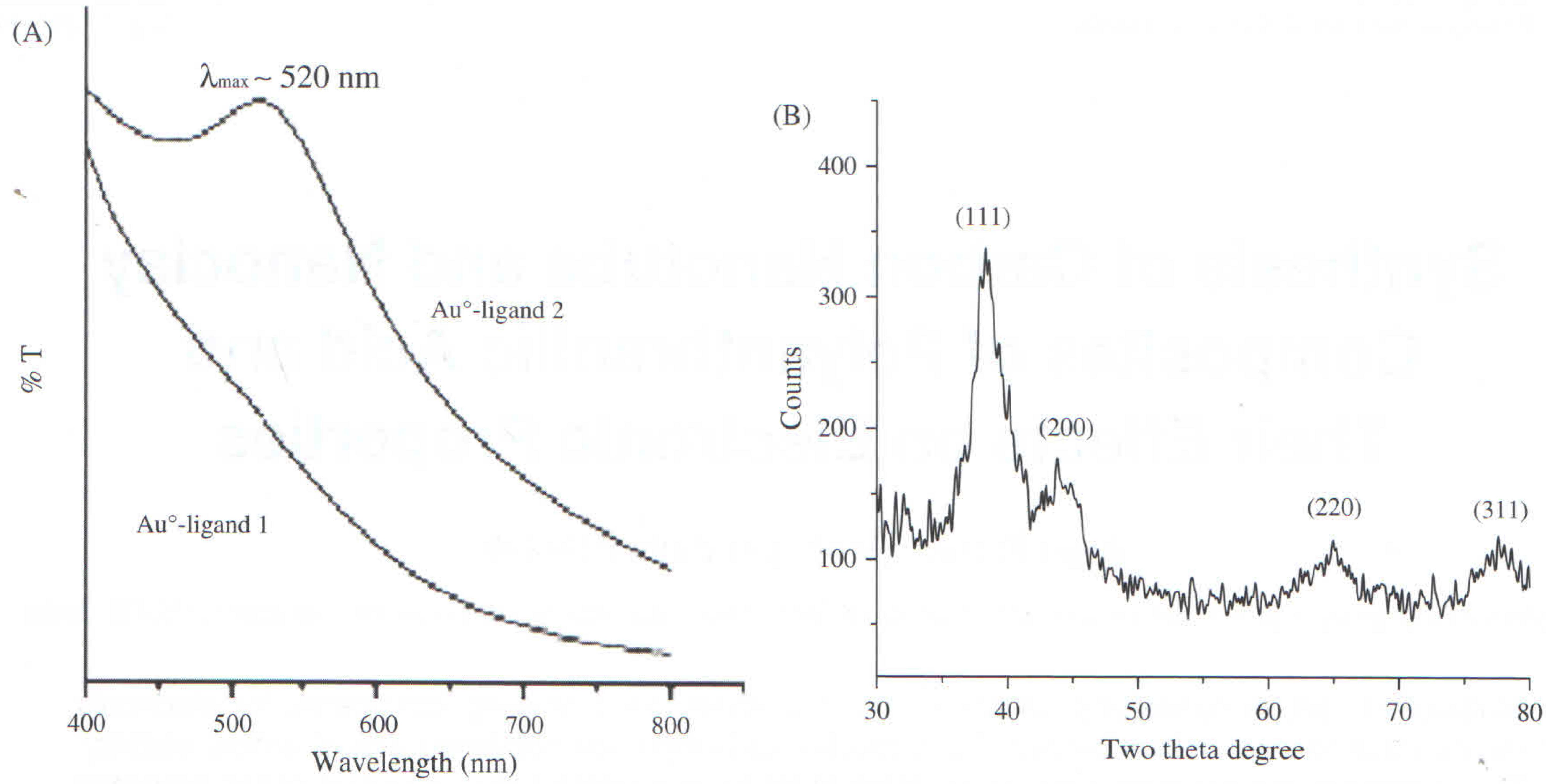

Fig. 1. (A) UV-Visible spectra and (B) Powder XRD pattern Au°-nanoparticles stabilized by ligand **2**.

Table I. Antimicrobial activities of Au°-nanoparticles.

	Inhibition zone diameter (mm)			
Bacteria used	Au° ligand 1	Au° ligand 2	Ligand 1	Ligand 2
Staphylococcus aureus	17	11	0	0
Escherichia coli	10	8	0	0

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