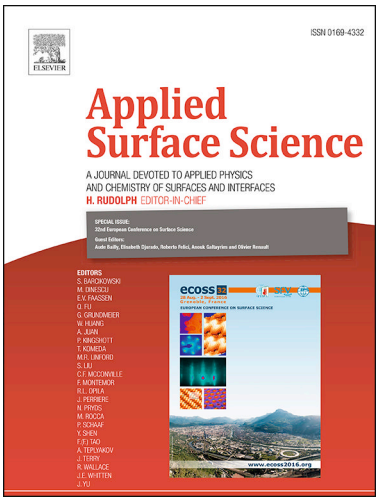
Accepted Manuscript




Full Length Article

# Polyethylenimine-assisted seed-mediated synthesis of gold nanoparticles for surface-enhanced Raman scattering studies

Anish Philip, Bright Ankudze, Tuula T. Pakkanen

PII: S0169-4332(18)30702-5
DOI: https://doi.org/10.1016/j.apsusc.2018.03.042
Reference: APSUSC 38790

To appear in: *Applied Surface Science*

Received Date: 27 September 2017
Revised Date: 18 January 2018
Accepted Date: 5 March 2018

Please cite this article as: A. Philip, B. Ankudze, T.T. Pakkanen, Polyethylenimine-assisted seed-mediated synthesis of gold nanoparticles for surface-enhanced Raman scattering studies, *Applied Surface Science* (2018), doi: https://doi.org/10.1016/j.apsusc.2018.03.042

# Polyethylenimine-assisted seed-mediated synthesis of gold nanoparticles for surface-enhanced Raman scattering studies

Anish Philip[a], Bright Ankudze[a], Tuula T. Pakkanen[a,*]

[a] Department of Chemistry, University of Eastern Finland, P.O. Box 111, FI-80101, Joensuu, Finland.

[*] Corresponding Author: tuula.pakkanen@uef.fi, tel. +358504354379.

## Abstract

Large-sized gold nanoparticles (AuNPs) were synthesized with a new polyethylenimine–assisted seed–mediated method for surface-enhanced Raman scattering (SERS) studies. The size and polydispersity of gold nanoparticles are controlled in the growth step with the amounts of polyethylenimine (PEI) and seeds. Influence of three silicon oxide supports having different surface morphologies, namely halloysite (Hal) nanotubes, glass plates and inverse opal films of $SiO_2$, on the performance of gold nanoparticles in Raman scattering of a 4-aminothiophenol (4-ATP) analyte was investigated. Electrostatic interaction between positively charged polyethylenimine-capped AuNPs and negatively charged surfaces of silicon oxide supports was utilized in fabrication of the SERS substrates using deposition and infiltration methods. The Au-photonic crystal of the three SERS substrate groups is the most active one as it showed the highest analytical enhancement factor (AEF) and the lowest detection limit of $1x10^{-8}$ M for 4-ATP. Coupling of the optical properties of photonic crystals with the plasmonic properties of AuNPs provided Au-photonic crystals with the high SERS activity. The AuNPs clusters formed both in the photonic crystal and on the glass plate are capable of forming more hot spots as compared to sparsely distributed AuNPs on Hal nanotubes and thereby increasing the SERS enhancement.

Keywords: Gold nanoparticles, polyethylenimine, seed-mediated synthesis, SERS, halloysite nanotubes, photonic crystals