Colloids and Surfaces A: Physicochem. Eng. Aspects 420 (2013) 46–52

Contents lists available at SciVerse ScienceDirect

Colloids and Surfaces A: Physicochemical and Engineering Aspects

journal homepage: www.elsevier.com/locate/colsurfa

Effect of cationic polyacrylamide dissolution on the adsorption state of gold nanoparticles on paper and their Surface Enhanced Raman Scattering properties

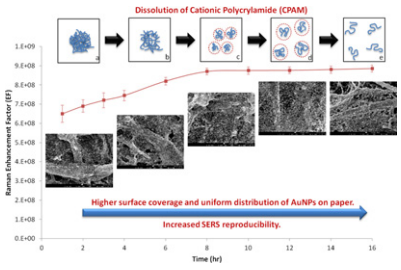
Ying Hui Ngo[1], Dan Li[2], George P. Simon[2], Gil Garnier[1,*]

[1] BioPRIA, Australian Pulp and Paper Institute (APPI), Department of Chemical Engineering, Monash University, Clayton, VIC 3800, Australia
[2] Department of Material Engineering, Monash University, Clayton, VIC 3800, Australia

HIGHLIGHTS

- Dissolution kinetic of CPAM greatly affected AuNPs distribution on paper.
- Higher charge density CPAM dissolves faster and produces uniformly distributed AuNPs for higher SERS reproducibility.
- Understanding CPAM dissolution kinetic is able to optimize SERS performance of AuNPs-paper.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 8 November 2012
Received in revised form
10 December 2012
Accepted 12 December 2012
Available online 20 December 2012

Keywords:
Cationic polyacrylamide (CPAM)
Dissolution
SERS
Gold nanoparticles (AuNPs)
Aggregates
Paper
Charge density
Reproducibility

ABSTRACT

This study examines and quantifies the effect of cationic polyacrylamide (CPAM) dissolution kinetics and charge density on the adsorption and aggregation state of gold nanoparticles (AuNPs) on paper and the resulting Surface Enhanced Raman Scattering (SERS) performance. Dissolution kinetics of CPAM of different charge density was studied by monitoring their viscosity and hydrodynamic diameter over regular intervals of time. It was found that the degree of dissolution of CPAM greatly affected the surface coverage and aggregation of AuNPs on the CPAM pre-adsorbed paper substrate and their SERS reproducibility. CPAM of higher charge density dissolves faster and produced a more uniform aggregation and higher surface coverage of AuNPs on paper for a higher and more reproducible Raman EF. Understanding the CPAM dissolution process enables the optimization of SERS performance of the AuNPs-paper as a bio-diagnostic platform.

1. Introduction

Paper has emerged as a substrate of choice in the fabrication of low-cost diagnostic platforms for medical and environmental applications [1–2]. One of these developing applications is bioactive paper diagnostic for blood typing, wherein blood agglutination is triggered by specific antibody–antigen interactions and indicated by chromatographic separation on paper [1–3]. However, bioactive papers often suffer from four major issues: Specificity, Selectivity, Sensitivity and Simplicity (4S). Among these issues, sensitivity can be a major limiting factor, with a detection range of 10^{-6} M for many colorimetric techniques. For certain applications, such as cancer detection, this can be inadequate and a detection range up to 10^{-9} or 10^{-12} M might be desirable. To address this issue, paper can be treated with metallic nanoparticles to produce a Surface Enhanced Raman Scattering (SERS) active substrate to identify analytes at trace levels [4–10].

* Corresponding author. Tel: +61 3 9905 9180
E-mail address: Gil.Garnier@monash.edu (G. Garnier).

0927-7757/$ – see front matter.
http://dx.doi.org/10.1016/j.colsurfa.2012.12.018