Application of single particle ICP-MS for silver nanoparticles characterization

Chiu-Hun Su1*, Chia-Chin (Donna) Hsu2, Chun-Hua Chen3, Meng-Tzu Lai1, Yen-Ying (Brian) Lai0, Ching-Heng (Jones) Hsu3
1 Industrial Technology Research Institute, Hsinchu, 31040, Taiwan
2 Agilent Technologies Taiwan Ltd., Taoyuan City 32450, Taiwan
3 BASF, Taoyuan City, 32853, Taiwan
Corresponding author email: ch.su@itri.org.tw; donna.hsu@agilent.com

ABSTRACT

The nanomaterials are widely used in various products of human life such as water purification equipment, anti-bacteria clothes and wearing. In this work, to understand the behavior and fate of nanoparticles in environmental, we investigated the particle size distribution and particle concentration of silver nanoparticles (Ag NPs) in four kinds of acidic matrix and environmental waters via spICP-MS. Comparison of the particle size stability of Ag NPs that spiked in HCl, CH3COOH, HNO3, and H2SO4 solutions (the pH value is about 5) for 72 hrs, the relative deviation (RSD) of particle size are 6.3% ~ 9.2% ~ 9.6% and 15.4%, respectively. It indicates that Ag NPs stored in H2SO4 matrix are the most unstable, followed by HNO3 matrix. And the disintegration rate of Ag NPs increase when pH value decreases. Furthermore, we spiked Ag NPs in industrial waste water, rain water (pH value is 5.29), artificial acid rain water (mixture of H2SO4, HNO3, and NH4OH and pH value is 5.24), tap water and ultrapure water. In short- and long-term stability tests, we found that Ag NPs spiked in industrial waste water are the most unstable, and the short-term (16–18 hrs) stability of Ag NPs is good in ultrapure water and tap water. In conclusion, with the present study we have demonstrated that Ag NPs in environmental waters cannot exist for a long-time, they might collapse into Ag ions or transformed in different types of particles, namely Ag2S and AgCl.

Experimental

Chemicals and Nanomaterials
Silver nanoparticles (40 and 100 nm (Sigma-Aldrich)) were acquired in stock suspensions at a nominal concentration of 20 mg Ag/L. Nano-Ag suspensions were made by diluting the stock solutions with 18.2 M-ohm Nanopure water (Millipore) to final concentrations, ranging from 1.25 to 100 ppt. Aqueous Ag standards (High-Purity Standards), used for calibration, were diluted in 1% nitric acid to concentrations 1 ppb. Nitric acid (HNO3) and Hydrochloric acid (HCl) (36%) from BASF, as well as Sulfuric acid (H2SO4) (98%) and Acetic acid (CH3COOH) (99.8%) from J.T. Barker were used to prepare the sample.

Instrumentation
An Agilent 7900 with Micromist nebulizer was used for single particle (SP) analysis, run at 1550 W RF power.

Stability testing of AgNPs in environmental waters

Comparison Results

Ag NPs spiked in industrial waste water are the most unstable

Reference

1. S. Wilbur, M. Yamanaka and S. Sannac, Agilent publication, 2015, 5991-5516EN.

**Single Nanoparticle Analysis**

**Agilent 7900 ICP-MS**

**Principle of spICP-MS**

**Workflow of spICP-MS**

**Dilution of AgNPs**

**Repeatability test of AgNPs**

**Stability testing of AgNPs (pH effects)**

**Stability testing of AgNPs (Matrix)**

**Experimental**

**Comparison Results**

**Reference**