Flexible porous aerogel decorated with Ag nanoparticles as an effective SERS substrate for label-free trace explosives detection

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Abstract

Homeland guards on country borders, airports and checkpoints are in urgent need of ultrasensitive methods for rapid and accurate detection of explosives.[1] 3-nitro-1,2,4-triazol-5-one (NTO) is a typical high energetic explosive with neurotoxicity and cytotoxity,[2] and it has very poor solubility and usually exists in the form of trace explosive residues.[3;4] Moreover, millions of tons of NTO have contaminated aquifers and soils in widely world since it was discovered and produced for military activities.[5;6] During the past decade, a variety of sensing methods had been explored for the detection of explosives. Among them, SERS has received much more attentions in view of it obtain the "fingerprint" information of the explosives, little need for sample preparation and portable instrument suitable for on-site inspection. In this work, for the first time we presented Ag nanoparticles decorated porous silica aerogel as flexible SERS substrates for sensitive, stable and label-free detection of explosive NTO. As shown in Fig.1, after sol-gel method and ethanol supercritical drying, we obtained flexible porous SiO_2 aerogels. These flexible SiO_2 aerogels have rich porosity, and own a good ability for absorption trace explosives. In particular, the incorporation of Ag nanoparticles within 3D SiO_2 aerogels to form hybrids structures was a useful strategy to enhance the mechanical properties and achieved certain SERS activity. And substrates showed good flexibility and can be texted directly after soaking or wiping the sample. Due to the strong adsorption capacity of porous structure, label-free strategy to detect explosives was accomplished directly. Enhancement factor of the SiO_2-Ag hybrids was calculated to be 1.25×10^6. NTO concentration as low as 7.94×10^{-10} M could be detected. All of Raman characteristic peaks were obtained, which can effectively avoid the interference from other chemical substances. This efficient and convenient method will be of great help to Raman's practical application in explosives detection.

Keywords

Flexible; aerogel; Ag nanoparticles; SERS; label-free; explosive detection

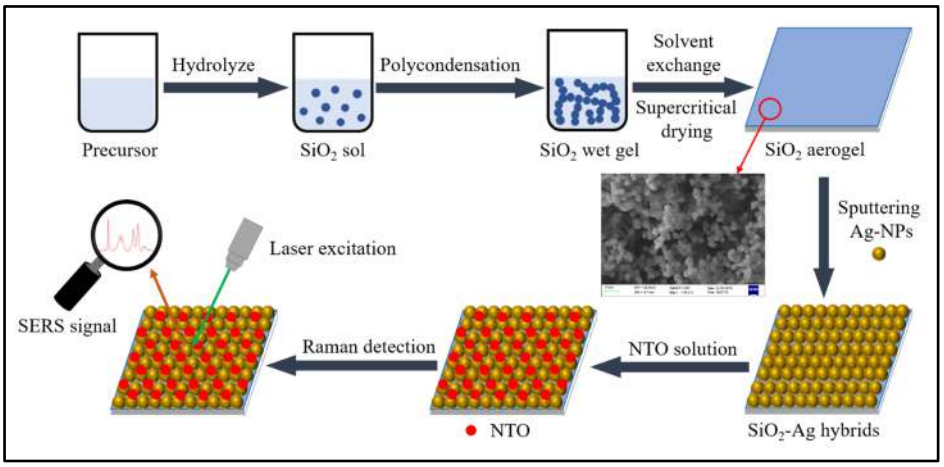

Fig.1 Schematic image of SiO_2-Ag hybrids substrate construction and application.

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