Development of Fibre-optic sensor based on Silver Nanoparticle embedded in Silica Matrix for High temperature/pressure conditions

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INTRODUCTION

Quantifying hydrogen ion concentration of a solution (pH) has important applications in different industries such as cosmetics, pharmaceuticals, textile, food and beverage, etc. However, it is challenging to maintain and detect accurately pH under conditions of high temperature and pressure (HTHP). At the moment, there is no reliable instrument that is capable of measuring pH at temperatures exceeding 100 °C in oil wells, or at elevated pressure and in the presence of aggressive chemical species.

OBJECTIVES

- To fabricate and characterize the surface plasmon resonance (SPR) pH sensor using coatings of silver nanoparticle embedded in silica matrix on optical fibre which can function in the HTHP condition.
- To determine the optimum conditions for the synthesis of silver nanoparticles embedded in silica matrix which are expected to have excellent optical and adhesive properties, durability and sensitivity, stable and decorate them on an optical fibre to form a pH sensor.

METHODOLOGY

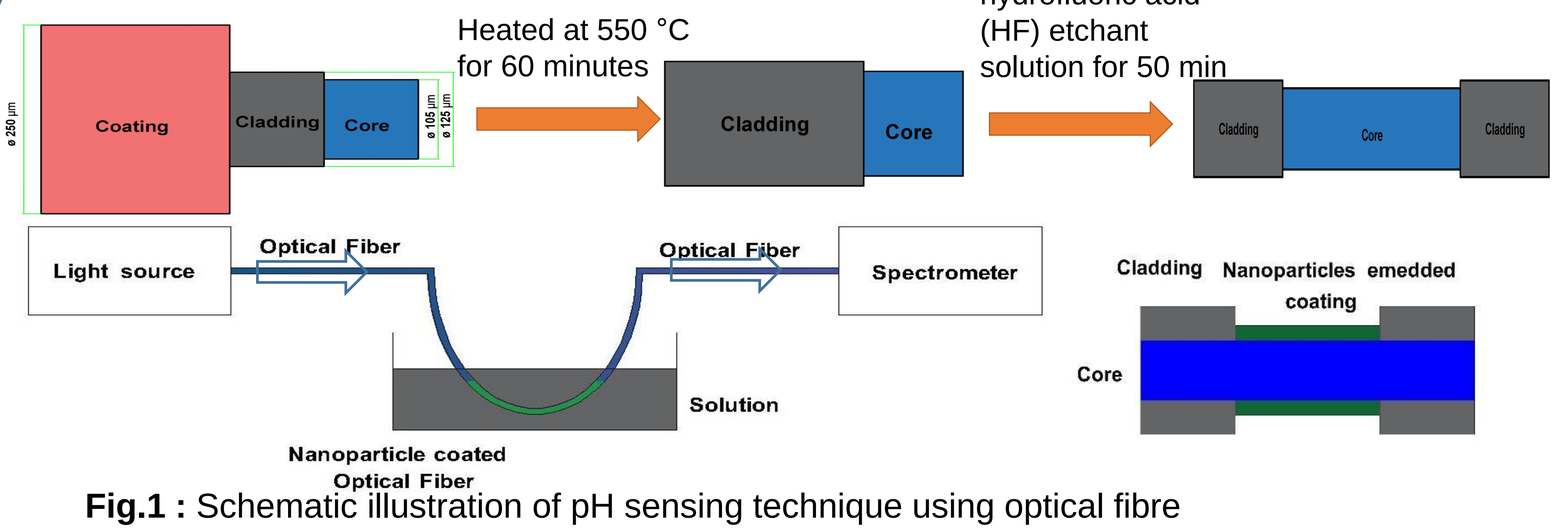
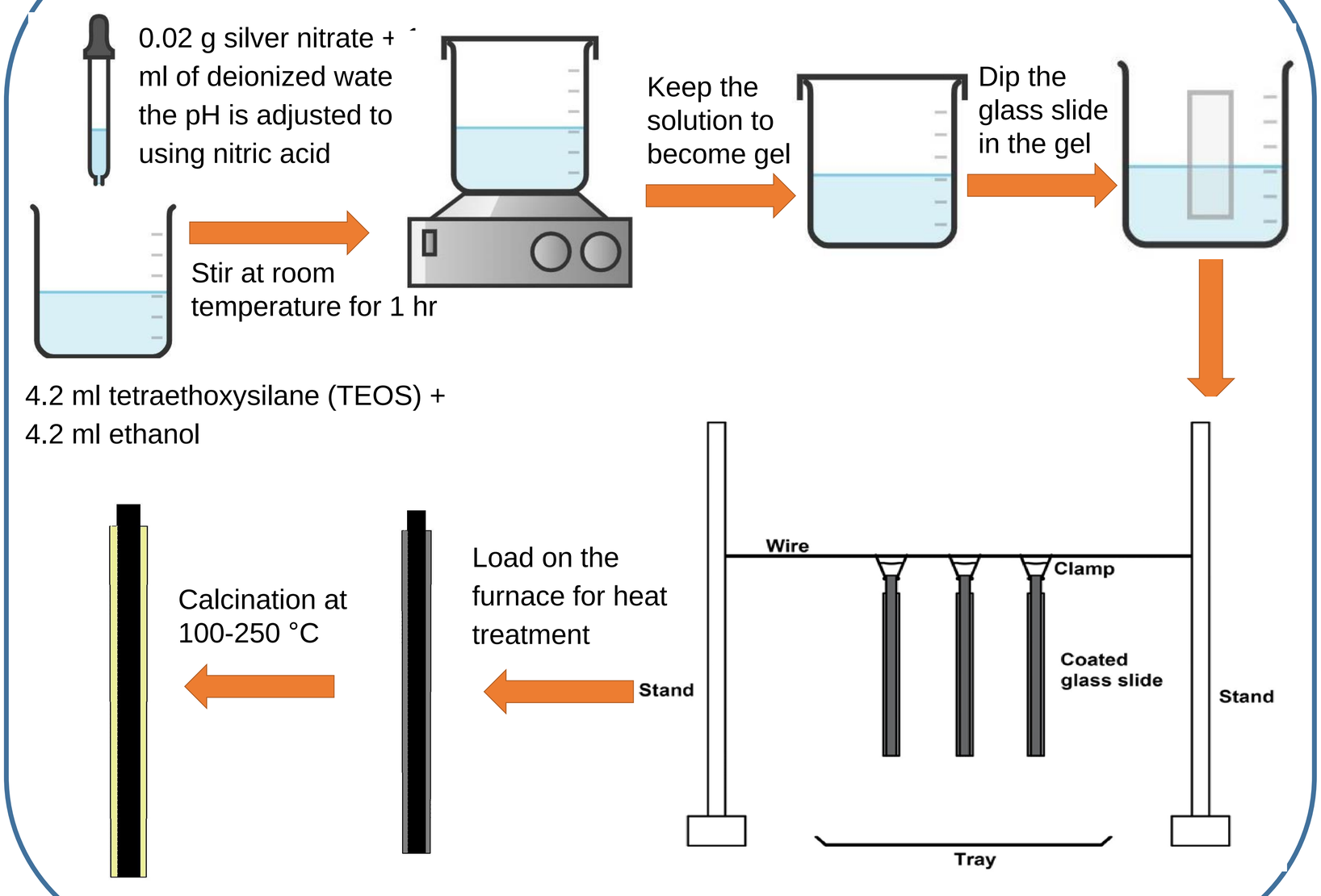


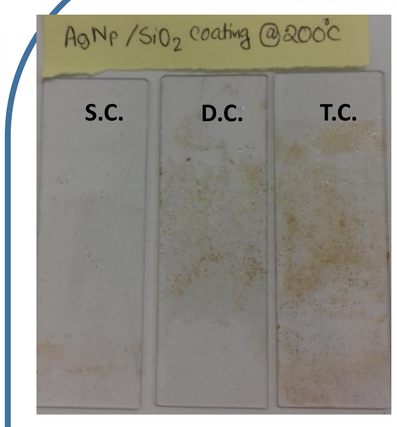
Fig.1 : Schematic illustration of pH sensing technique using optical fibre

Nanomaterials exhibit very strong size-dependent localized surface plasmon resonance (LSPR) with the absorption maxima at a particular wavelength of light. The spectral position of LSPR is sensitive to the pH of its local environment [1-2], which can be used to fabricate a sensor.

EXPERIMENTS



RESULTS



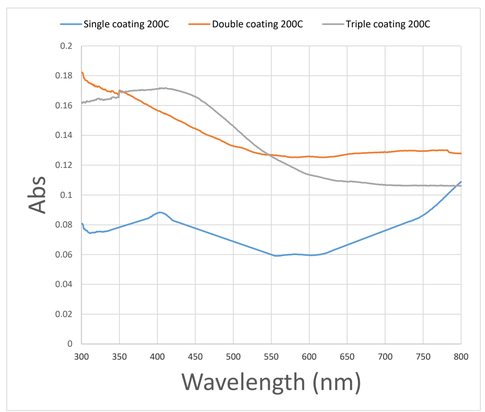
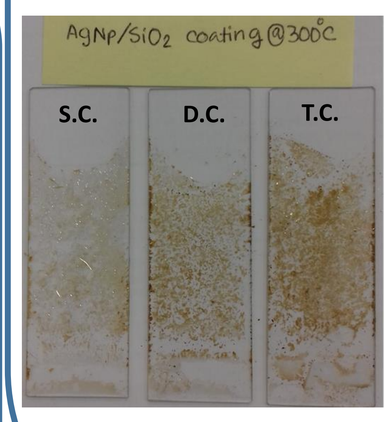


Fig.2 :Coating of Silver nanoparticle embedded in silica Calcination at 200 °C



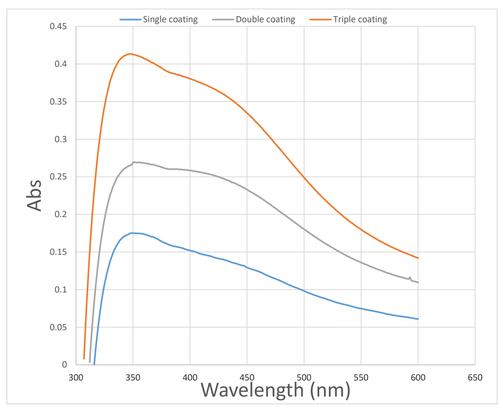


Fig.3 :Coating of Silver nanoparticle embedded in silica Calcination at 300 °C

S.C.: Single coating , D.C.: Double coating, T.C.: Triple coating

- During calcination, silver nanoparticles are produced. The light absorbed near 400nm wavelength corresponds to the presence of silver nanoparticles on the coating.
- Calcination at 200 °C yielded more silver nanoparticles during triple coating and has a better adhesive property with the glass than at 300 °C.
- Calcination at 300 °C yielded increasing silver nanoparticles on the coating.

CONCLUSIONS

- Silica is a well known matrix and it is thermally stable at high temperature and high pressure.
- Parameters such as reaction temperature, pH and concentration of reactants have significant impact on the gelation time.
- The heat treatment on coating plays an important role in the formation of silver nanoparticles and in the adhesiveness to the glass.

FUTURE WORK

- To improve on the technique for the synthesis of silica coating in order to obtain a matrix with excellent optical and adhesive properties, durability and sensitivity.
- Apply the coating on fibre optic and implement as a pH sensor.
- Check and verify the sensitivity of the pH sensor against the standard buffer.

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