

pH sensor using silver nanoparticles embedded in silica-coated optical fibres

S. Debnath¹, Y-C. Chen¹, T. Green¹, G. Hinds², S. Roy¹

¹Department of Chemical and Process Engineering, University of Strathclyde, Glasgow, United Kingdom, G1 1XL

²National Physical Laboratory, Hampton Road, Teddington, United Kingdom, TW11 0LW

Abstract: Quantifying hydrogen ion concentration in solution (or pH) has important applications in different industries. However, measurement of pH at high temperature and pressure (HTHP) remains a significant challenge, due to lack of reliable instrumentation. Recent studies on the surface plasmon resonance (SPR) of gold nanoparticles coated on optical fibres exhibited sensitivity to pH in solutions at different temperatures and pressures [1,2]. Since optical fibres are stable under HTHP conditions, these findings indicate a potential way forward to develop pH sensors capable of operating in such environments.

This work reports on the development of silver nanoparticle embedded silica (SiO₂) coatings on optical fibres. The coatings were prepared using the sol-gel technique by adding tetraethoxysilane (TEOS) to ethanol, water and silver nitrate. In order to determine the optimum conditions for formation of a gel with good adhesiveness on glass, while containing sufficient silver nanoparticles for pH sensitivity, experiments were carried out by coating glass slides (Fisher Scientific, 26 mm × 76 mm × 1.2 mm) at different temperatures and reaction times as shown in Figure 1(a).

It was observed that gel formation at 35 °C for 48 hours showed good adhesiveness with glass. After preparing the gel, glass slides were then dip-coated and dried in an oven at 200 °C for 2.5 hours, where silver ions were reduced to form silver nanoparticles. Characterization of the coating using Ultraviolet/Visible (UV-Vis) spectroscopy as shown in Figure 1(b) showed an absorbance peak at around 400 nm, which is consistent with the presence of silver nanoparticles [3].

Once the preparation method had been established, a piece of optical fibre was etched in 7 M NaOH to remove the outer coating and cladding, before being coated with the gel as shown in Figure 1(c). The coated optical fibre was observed under a high-resolution microscope and was found to have 5-6 microns of the coating

around the core of the fibre. Ongoing experiments are focused on connecting these fibres to a light source and UV-Vis spectrophotometer and measuring absorbances in solutions of different pH, which will be reported at the meeting.

Keywords: pH sensor, silver nanoparticles, sol-gel technique.

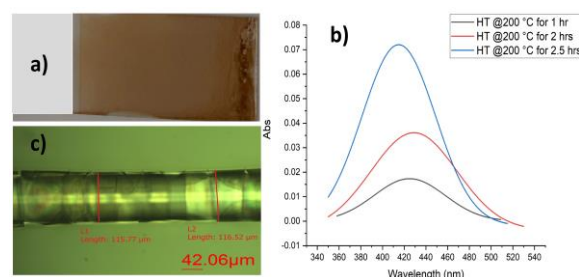


Figure 1: a) Silver nanoparticle/TEOS coating on a glass slide heat-treated at 200 °C for 2.5 hours; b) UV-Vis spectra of coated glass slides for samples heat-treated at 200 °C for 1, 2 and 2.5 hours, showing an absorption peak near 400nm, indicating the formation of silver nanoparticles; and c) Silver nanoparticle/TEOS coating on the core of an optical fibre.

References:

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