New Alipore College

Department of Chemistry

Project

On-going Project of Dr. Sudipta Ghosh funded by New Alipore College

Project Title:

A new fabrication methodology to fabricate permanent gold nanoparticles (AuNPs) embedded optical fibre SPR sensor without any AuNPs supporting material through homogeneous micropore formation on the fibre surface

In the present research scenario, SPR-based AuNPs embedded optical fibre sensors will be a potential candidate due to their high detection efficiency, accuracy, and real-time remote monitoring capability. Nanoparticles integrated optical fibre SPR sensors-based research has increased in the last decade, almost 55,200 articles have been reported since 2000 shown in figure 1. It is a considerable small integrated system with long durability, low electromagnetic interference, and environment friendly; long-range temperature permanence proves its dominant reliability. It has shown a diverse field sensors application like environmental, chemical, biomedical, and infrastructural make such material more important and demanding. So far, different types of optical fibre SPR sensors have been fabricated through several fabrication methods to use in diverse applications. Among them, polymer doping-dispersion of metal nanoparticles6, dip-coating nanoparticles film, electrostatic layer by layer self-assembly, molecular imprinting, laser-induced deposition fabrication methods were used to fabricate such SPR based sensors. Considering all the various fabrication methodology and their applications in different sensing fields, there is a huge demand for a new, easy, and cost-effective fabrication methodology, which can overcome glass poor adhesion problems and give us pure AuNPs embedding optical fiber without any help of supporting materials. Another

significant issue is that the AuNPs need to be functionalized by different functional materials for most of the SPR sensors to use as sensors, which become stumbling blocks to reproducibility for such sensors. For that, an ingenious design of optical fiber structures needs to be developed which can give an excellent analyte-AuNPs interaction leading to high sensitivity and can show reproducibility and longevity with better control over AuNPs size, shape, and distribution.

Here, we proposed a fabrication methodology that will give us a permanent homogeneous AuNPs doped optical fibre with nanocavity on the fibre surface without any AuNPs supporting and auxiliary activating materials shown in Scheme 1. Chemical Vapour Etching (CVE) of HNO_3/HF was introduced to generate nanopore silica surface on the fibre surface which creates a suitable host for AuNPs. We used the gold sputtering process, an external source of gold with controllable parameters (current and sputtering time), to incorporate gold on the fibre surface. Later isothermal annealing was performed to generate AuNPs with a unique nanocavity on the embedded surface of optical fibre. We believe the fabrication process can be used for all types of glass-based optical waveguides to fabricate different sensor materials.

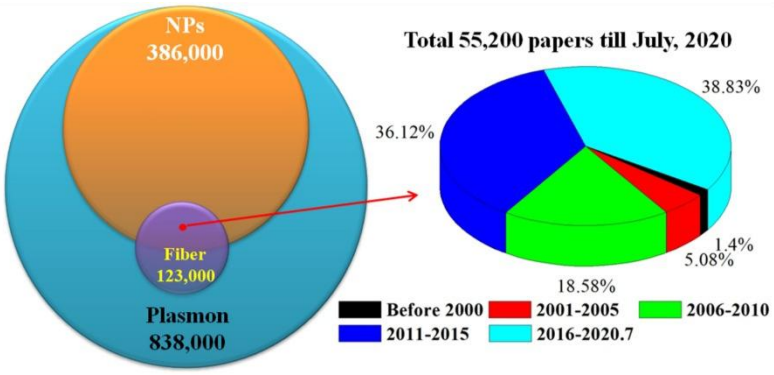
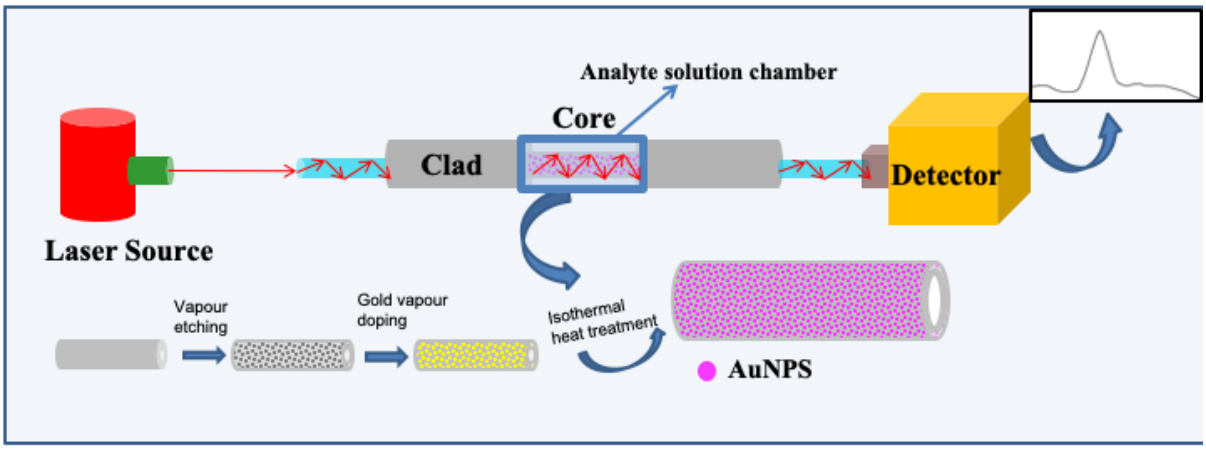


Figure 1: *Diagram of published research articles on metal nanoparticles integrated optical fibre SPR sensors (Ref: 1).*



Scheme 1: *Schematic diagram of fabrication methodology and sensing experimental setup of AuNPs embedded optical fibre SPR sensor.*

Publication: S. Ghosh, N. Choudhury, D. Dutta, D. Mondal, M. Chandra Paul, S. Das, A. Dhar, "In situ growth of AuNPs with a nanocavity on the surface of optical fibre for development of SPR sensor, Ceramics International, Volume 49, Issue 18, 2023, Pages 30623-30630, ISSN 0272-8842,

https://doi.org/10.1016/j.ceramint.2023.07.015.