Summary Report of

UGC-MINOR RESEARCH PROJECT

No: 2365-MRP/15-16/KLMG002/UGC-SWRO

(Project Period 01-06-2016 to 31-05-2018)

Synthesis and characterisation of plasmonic nanoparticles doped thin films for solar cell application

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Summary Report of the Minor Research Project

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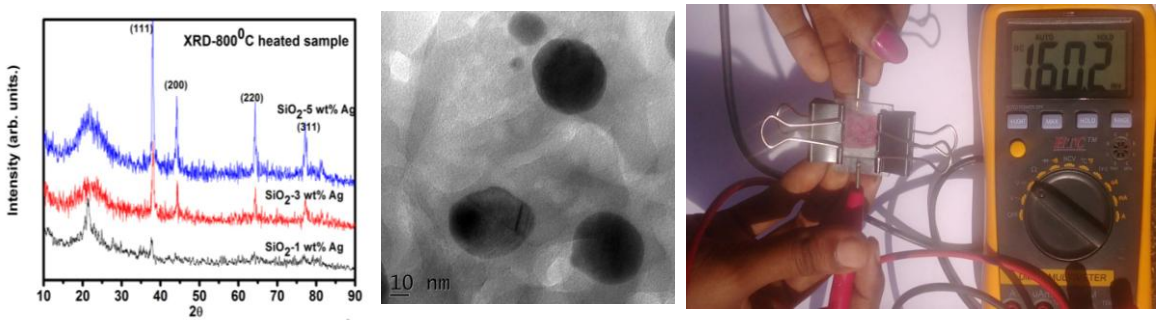
Researchers have established different synthesis routes for synthesis of metal nanoparticles like melt-quenching, ion implantation, ion exchange , high-temperature glass fusion, sol–gel techniques etc, are few such methods. In particular, the sol-gel method has several advantages over other methods such as high purity, ultra homogeneity, low processing temperatures, and most significantly the possibility of making glasses of new compositions. The reasons for such a productive application of the sol– gel process can be identified in the molecular scale homogeneity of the starting solutions and the possibility of incorporating many different metal dopants into different matrixes. The transparency in the UV–visible range, good mechanical strength, chemical inertness and large 3D porous network etc are the several advantages of sol-gel synthesised amorphous SiO_2. Therefore, make use of of such a mesoporous medium yields an interacting nanostructure where metal nanoparticles are highly dispersed and in good contact with the atmosphere. Due to strong plasmon absorption in the visible region for the metal nanoparticles have potential applications in, optical device, biomedical application, chemical companies, drug delivery, energy, optoelectronics, catalysis, single electron transistors, metamaterial absorbers, enhancements for fluorescence signal, light emitters, non-linear optical devices and photo-electrochemical applications. Metal nanoparticles with plasmonic effect are being given considerable attention for the past few decades due to their potential applications in in solar cell.

The plasmonic effect of Silver and copper nanoparticles in silica/titanosilicate matrices are synthesized by means of hydrolytic and non hydrolytic sol–gel method. Sol-gel technique is used for the synthesis of highly dispersed nanoparticles in

silica/titanosilicate matrices. In the present study we used raw materials such as TEOS (tetraethyl orthosilicate, $Si(OC_2H_5)_4$) ,TIP(Titanium (IV) iso propoxide, $(Ti[OCH(CH_3)_2]_4)$, Ethanol (C_2H_5OH), Silver Nitrate ($AgNO_3$) , $Cu(NO_3)_2.3H_2O$, Nitric acid (HNO_3). We successfully synthesised Silver and copper nanoparticles in silica/titanosilicate and various structural and optical characterizations were carried out by Fourier-transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), Transmission electron microscopy (TEM), The optical spectra of the samples were taken by using UV-Vis Spectrophotometer. Plasmonics is an important field that makes use of the nanoscale properties of metals. We studied in detail the plasmonic absorption variation with temperature and metal ion concentration at different sol-gel matrices like silica/titanosilicate. The plasmonic absorption was confirmed by using UV-Vis absorption studies. The FTIR studies confirmed the bond formation of Si-O-Si and Si-O-Ti. The XRD studies reveal the cryatalline nature of the metal nanoparticles. The TEM and HR-TEM confirmed the crystal planes and size of the nanoparticle. Finally we successfully integrate the Plasmonic effect of metal nanoparticle in DSSC solar cells. The DDSC solarcell is fabricated using the FTO glass coated with a film of silica/titanosilicate integrated with metal nanoparticles and different dye (extracts of flower/leafs/fruits available). we got an DSSC output voltage of ~160mV by using Ag nanoparticle and Spinach leaf extract as dye.



(a) XRD- SiO_2: Ag nanoparticle (b) TEM of synthesised Ag nanoparticles
(c) DSSC with SiO_2-TiO_2+Ag3% measured out put voltage

International Journal Publication

1. Surface Plasmon response of silver nanoparticles doped silica synthesised via sol-gel route**,** **Arun Kumar K V**, Jini John, Sooraj T R, Shedhal Anu Raj, N V Unnikrishnan, Nivas Babu Selvaraj, ***Applied Surface Science*** (2018)
   (Online published, DOI.org/10.1016/j.apsusc.2018.05.178)
2. Sol-gel synthesized silver nanoparticles doped silica/titanosilicate films for plasmonic solar cell applications, **Arun Kumar K V,** R. Seema, R Aiswarya, and V R Vineetha**,** ***American Institute of Physics Conference Proceedings*** 1849, 020017 (2017)

Seminar/Conference papers

1. Optical and structural characterisation of sol-gel synthesised plasmonic nanoparticles annealed at different temperature, Sooraj T R, Jini John, Shedhal Anu Raj, **Arun Kumar K V**, National Seminar on Materials for Emerging Technology, CMS College , Kottayam, November 2017
2. Synthesis of pure and silver doped zinc oxide nanoparticles using co-precipitation methods and its characterization, International conference on emerging areas in materials Engineering (AICERA 2017), Seema R ***& Arun Kumar K V***, , Amal Jyothi College of Engimeering, Kanjirappally, July 2017
3. Sol-gel synthesized copper nanoparticles in silica matrix for plasmonic solar cell applications, ***Arun Kumar K V***, Reeja Raju, Renu S Leya, Conerence Proceeding P004 Page 37-38, National Seminar on Nanophotonics -2017, St Thomas College Thrissur
4. Sol-gel synthesized silver nanoparticles doped silica/titanosilicate films for plasmonicsolar cell applications, ***Arun Kumar K V***, Seema R, Aiswarya and Vineetha, Optics 17, National conference on light, National Institute of Technology, Calicut, January 2017

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