Design and Development of Organosilanes assisted Functional Nanomaterials for catalytic applications

Prem C. Pandey, Department of Chemistry, Indian Institute of Technology (BHU), Varanasi-221005, India

Abstract

Functional nanomaterials have received great attention as the presence of organic functionality together nanostructured domain introduce unprecedented chemical and physical properties bridging the gap between physics, chemistry, biology, medical and engineering disciplines. The present talk is focused on the role organosilanes where reactive organic functionalities like amino-, glycidoxy-, Epoxy-, linked to alkoxysilane allow the formation of such functional nanomaterial in a controlled manner via variety of routes: (1) controlling the presence of hydrophobic and hydrophilic functional group a appropriate ratio allow the formation of nanostructured porous thin film of organically modified silicate via sol-gel processing most suitable for encapsulating the active sensing element over targeted surface with additional advantages including: (a) the presence of organic functionality like amino- group enable stabilization of bioactive molecule like active enzyme within nanostructured domain retaining biological activity for practical application along with introducing coupled bioelectrocatalysis during signal processing; (b) the presence of reactive organic functionality allow extra event even before and after the formation solid-state nanostructured network of organically modified silicate in anchoring the selective material like palladium introducing the formation of Pd-C-, and -Pd-Si- linkages and the resulting nanostrucured domains behave like a solid solution, (c) these organic functionalities facilitate the encapsulation of several active molecules like ion carrier and ion-exchanger within nanostructure domain introducing the excitable properties suitable for many practical applications; (2) the organosilane like 3-aminopropyltrimethoxysilane (3-APTMS) and 3-glycidoxypropyltrimethoxysilane (3-GPTMS) allow selective reduction of noble metal cations into respective nanoparticles introducing novel rout for making functional noble metal nanoparticles, bimetallic nanoparticles and their multimetallic analogues with advancement over conventional rout of nanoparticles synthesis e.g.; (i) 3-APTMS and 3-GPTMS allow the formation of relatively high concentrations of noble metal nanoparticles with relatively high stability as colloidal suspension, (ii) noble metal nanoparticles could be made at various ratio of 3-APTMS and 3-GPTMS allowing the nanoparticles dispersion in wide variety of polar and non-polar solvent without further addition of any additive in colloidal suspension, (iii) 3-GPTMS can be replaced with small organic reducing agent like, cyclohexanone, formaldehyde, organic hydroperoxide, acetone and many more that further allow to control the process of nanoparticles synthesis in the presence of 3-APTMS for specific applications, (iv) 3-APTMS and 3-GPTMS undergo microwave activation allowing controlled and rapid synthesis of noble metal nanoparticles and their multimetallic analogues within few seconds; (v) functional activity could again be explored to link active molecules with noble metal nanoparticles for selective recognition, (vi) 3-APTMS and 3-GPTMS could be explored in making palladium silica alginate beads of controlled porosity for immobilizing nanoparticle like palladium and nickel at one end and biological active molecule for many practical application; (3) 3-APTMS undergo the formation of siloxane polymer in aprotic non-polar volatile solvents with exceptional properties enabling: (x) reduction of noble metal cation into respective nanoparticle, (y) formation of thin film of controlled porosity for multiple biomedical application. The speech will cover important issues on these lines.

Recent Publications

P. C. Pandey Shubhangi Shukla. Solvent dependent fabrication of bifunctional nanoparticles and nanostructured thin films by self assembly of organosilanes Journal of Sol-Gel Science and Technology, **2018, 86:650– 656**

P. C. Pandey Gunjan Pandey. One-pot two-step rapid synthesis of 3-amino propyltrimethoxysilane-mediated highly catalyticAg@(PdAu) trimetallic nanoparticles. Catal.Sci.Technol., 2016, 6: 3911-3917.

P. C. Pandey, S. Shukla, Y. Pandey. 3-Aminopropyl-trimethoxysilane and graphene oxide/reduced graphene oxide-induced generationof gold nanoparticles and their nanocomposites: electrocatalytic and kinetic activity. RSC Adv., 2016, 6, 80549

P. C. Pandey, G. Pandey , A.Walcarius. 3-Aminopropyl-trimethoxysilane mediated solvent induced synthesis of gold nanoparticles for biomedical applications Materials Science and Engineering C, 2017, 79 : 45 –54

P. C. Pandey, S. Shukla, Y. Pandey. Mesoporous silica beads encapsulated with functionalized palladium nanocrystallites: Novel catalyst for selective hydrogen evolution. J. Mater. Res. 2017, 32: 3574-3584



Biography

Prem C. Pandey is Professor (HAG) at department of Chemistry Indian Institute of Technology (BHU), Varanasi, India. He has an MSc from Gorakhpur University University and Ph.D. in the area of Applied Electrochemistry from same university. He has been working on electrochemical Biosensors/Sensor since 1995 and has published > 200 publication, four books. He has 40 patents on various aspects of nanostructured materials. He has visited various international research centers in several countries ad delivered technical lectures on Biosensors and functional nanoparticles.

Email: pcpandey.apc@iitbhu.ac.in; https://iitbhu.ac.in/dept/apc/people/pcpandeyapc