Name of Scholar: **Ajeet Kumar Kaushik**

Name of Supervisor: **Prof. Sharif Ahmad (Department of Chemistry, Jamia Millia Islamia,)**

Name of Co-supervisor: **Dr. B. D. Malhotra (National Physical Laboratory, New Delhi)**

Department: **Department of Chemistry, Jamia Millia Islamia, New Delhi**

Title of thesis: **Organic-Inorganic Hybrid Nanocomposites for Sensing Application**

ABSTRACT

The organic [Chitosan (CH)] - inorganic (metal oxide nanoparticles) hybrid nanocomposites have gained much interest for the development of electrochemical biosensor. These interesting materials exhibit the properties of both the counterpart molecules along with some unique properties that are absent in parent molecules. The properties of nanocomposite materials depend not only on the properties of their individual parts but also on their morphology and interfacial characteristics. These unique properties of organic-inorganic hybrid nanocomposites can be exploited for various applications such as mechanically reinforced lightweight components, non-linear optics, battery cathodes, nanowires, optics, electronics, ionics, mechanics, membranes, protective coatings, catalysis and sensors.

Present thesis deals with the preparation and characterization of nanobiocomposite film based on CH and metal oxides nanoparticles such as cerium oxide (CeO_2), fumed silica (SiO_2) and iron oxide (Fe_3O_4) onto ITO substrate. Excellent film forming ability of CH and high electocatalytic properties of metal oxide nanoparticles make these nanostructured biocomposites as potential candidates to co-immobilize rabbit-immunoglobulin (r-IgGs) antibodies and bovine serum albumin (BSA) to block non-binding sites of r-IgGs/CH-metal oxide/ITO immunoelectrode to detect ochratoxin-A (OTA).

Surface charged CH and nanostructured CeO_2 film fabricated onto ITO have been utilized to detect OTA via immobilization of immunoglobulin (r-IgGs) and bovine serum albumin (BSA) to block the non-specific binding sites. It has been shown that the CeO_2 based immunosensor shows improved characteristics than that of CH based immunosensor. It is observed that the availability of functional group and surface affect the loading of antibodies. Keeping this in view, NanoCeO_2 have been incorporated into CH matrix to fabricate CH-NanoCeO_2 nanobiocomposite film for the detection of OTA. Electrochemical response of BSA/r-IgGs/CH-NanoCeO_2/ITO

immunoelectrode obtained as a function of OTA concentration exhibits better sensing characteristics than that of CH and CeO_2 based immunosensor.

CH-SiO_2 nanobiocomposite have been used for OTA detection. The observed three-dimensional (3D) arrangement of NanoSiO_2 in the CH matrix via hydrogen bonding available NH_2/OH groups and excellent film forming ability of CH results in increased effective surface area of CH-NanoSiO_2 nanobiocomposite for the r-IgGs immobilization resulting in enhanced electron transport between r-IgGs and electrode.

Surface charged superparamagnetic Fe_3O_4 nanoparticles, synthesized using co-precipitation method have been self-assembled in CH matrix to fabricated CH-Fe_3O_4 nanobiocomposite. As fabricated nanobiocomposite have been used to co-immobilized r-IgGs and BSA for detection of OTA. It is observed that in the nanobiocomposite, NanoFe_3O_4 results in increased electroactive surface area wherein, affinity of surface charged NanoFe_3O_4 for oxygen support the immobilization of r-IgGs leads to enhanced electron transfer. The BSA/r-IgGs/CH-NanoFe_3O_4/ITO immunoelectrode shows improved sensing characteristics such as low detection limit (0.5 ng dL^{-1}), fast response time (18s) and high sensitivity (36 μA/ng dL^{-1} cm^{-2}).

The sensing characteristics of CH, CeO_2 and CH-metal oxide nanobiocomposite based immunosensors for OTA detection are summarized in table.

Table 1 Sensing performances of various immunosensors for OTA detection.

Immunosensing Parameters	CH/ITO	Nano-CeO_2/ITO	CH-NanoCeO_2/ITO	CH-NanoSiO_2/ITO	CH-NanoFe_3O_4/ITO
Linear Range	1-6 ng dL^{-1}	0.5-6 ng dL^{-1}	0.5-6 ng dL^{-1}	0.5-6 ng dL^{-1}	0.5-6 ng dL^{-1}
Detection Range	1 ng dL^{-1}	0.5 ngdL^{-1}	0.25 ng dL^{-1}	0.3 ng dL^{-1}	0.25 ng dL^{-1}
Sensitivity	4.6 x 10^{-8} A/ng dL cm^{-2}	1.24 μA/nd $dL^{-1}cm^{-2}$	17 μA/nd $dL^{-1}cm^{-2}$	18 μA/nd $dL^{-1}cm^{-2}$	36 μA/nd $dL^{-1}cm^{-2}$
Response Time	35s	30s	25s	25s	18s
Association Constant	0.6 x 10^{8} L mol^{-1}	0.9 x 10^{11} L mol^{-1}	4 x 10^{12} L mol^{-1}	2 x 10^{12} L mol^{-1}	9 x 10^{12} L mol^{-1}
Shelf- Life	30 days	60 days	80 days	80 days	45 days
Regression Coefficient	0.98	0.997	0.998	0.99	0.989