ABSTRACT OF THE THESIS entitled "***Polymer mediated Metal Nanoparticles and their Applications***" submitted to The Maharaja Sayajirao University of Baroda for the degree of Doctor of Philosophy in Applied Chemistry by **Patel Saurav Sureshbhai** under the supervision of **Dr. Rakesh K. Sharma**

Metal nanoparticles (MNPs) (sizes ranging from 1-100 nm) are an attractive class of nanomaterials that have attracted the scientists, engineers, and researchers from several fields of study. The properties of MNPs diverge dramatically from those of their bulk counterparts; the most noticeable are their nanosize and high surface area relative to volume. These properties make them effective for catalysis and adsorption applications. Polymers play an important role in the synthesis of MNPs as they act as templates, stabilizers, and growth regulators for potent MNPs. By modifying the polymer's properties, such as chain length or functional groups, one can tailor the MNPs to desired specifications. Polymer mediated MNPs often exhibit enhanced properties compared to simple MNPs with a combination of polymer and MNP properties.

In the present thesis work, Pluronic surfactants (PEO-PPO-PEO triblock copolymers), also known as Poloxamers, were used for the development of polymer mediated MNPs. Pluronics act as stabilizing agents for MNPs by forming a protective layer around them. This prevents their aggregation, ensuring colloidal stability and preventing the MNPs from undergoing precipitation or agglomeration. The amphiphilic nature of Pluronics allows for control over the size and morphology of MNPs with adjusting the concentration, composition, and molecular weight of Pluronics. The synthesis of MNPs using Pluronics is relatively straightforward and scalable, making it an attractive method for large-scale production. Not only that, the other polymer that has also been used in the present thesis work is chitosan for the development of MNP composites. Herein, copper nanoparticles (CuNPs) and silica nanoparticles (SiO_2NPs) were synthesized using Pluronics as stabilizing agents and/or capping agents and other chitosan as a modifier for their useful applications of antimicrobial activity, dye degradation, gas adsorption, and dye removal.

The better efficiency and decrease in particle size of synthesized Pluronic mediated CuNPs were observed with increasing the concentration of Pluronic. The CuNPs are fcc-structured,

crystalline, and free of any impurities of CuO or Cu_2O and showed highly potent antimicrobial activities. Highly hydrophilic Pluronic showed the best in reducing the CuNPs particle size compared to hydrophobic Pluronic. The synthesized Pluronic mediated CuNPs worked successfully as a powerful photocatalyst for the degradation of textile anionic (CR and MO) and cationic (MB and RhB) dyes.

Other SiO_2NPs (92.84% SiO_2 content, spherical, 18 nm-in-size) were also synthesized from peanut shell ash (PSA) assisted through various Pluronics. Pluronic mediated SiO_2NPs were reacted with chitosan without any crosslinkers or activators to develop chitosan-modified SiO_2NPs (Ch/SiO_2NPs) biosorbents. The Ch/SiO_2NPs have porous (pore volume: 0.83 cm^3/g and pore size: 1.35 nm), sphere-shaped, uniformly coarse surfaces (surface area: 830 m^2/g), and an average particle size of 45.8 nm. The Ch/SiO_2NPs exhibit a strong attraction towards organic molecules and showed good adsorption of CO_2, CH_4, and N_2 gases. It showed exceptional selectivity for CO_2 when compared to N_2, with a selectivity ratio (SCO_2/N_2) of 16.50. The biosorbent has proved a promising material for catalytic applications. The synthesized $Ch_{1.0}$/SiO_2NPs biosorbent has performed significantly for CR dye adsorption and shows almost 98.40% CR removal efficiency with a dose of 50 mg, following the pseudo-second-order kinetics. The Ch/SiO_2NPs were reusable up to six cycles after CR adsorption, which was commendable. The biosorbents have found potent materials for dye removal studies from waste water treatment or textile effluents.

Overall, the present thesis work demonstrated the synthesis of polymer mediated MNPs (specifically CuNPs and SiO_2NPs) using Pluronic polymers as main stabilizing agents and/or reducing agents along with conventional ones. The developed Pluronic mediated CuNPs showed excellent antimicrobial and dye degradation applications, and Pluronic mediated SiO_2NPs, when modified with chitosan, found better adsorbents for applications of gas adsorption and organic dye removal.