PRF # 57010-UR10

Project Title: Green Gold Nanoparticles for Catalytic Reduction of Nitrophenols

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As their uses continue to grow a simple, one-step, ecologically friendly method of synthesizing AuNPs is in growing demand. The synthesis presented here makes use of saccharides to act as both the reducing and capping agent for the AuNPs with the reaction medium being water. We have utilized the combined reducing/capping ability of naturally available saccharides like fructose, dextrose, sucrose, maltose, maltotriose and raffinose to synthesize saccharide-conjugated nanoparticles (Sac-AuNP) (Figure 1). Using various Sac-AuNPs we are currently evaluating and comparing the catalytic properties of saccharide conjugated AuNPs (including Fru-AuNPs, Dex-AuNPs, Mal-AuNPs, Suc-AuNPs, Maltri-AuNPs and Raf-AuNPs), using a model reaction system based on the reduction of p-nitrophenolate in presence of sodium borohydride ($NaBH_4$) (Figure 2). In conclusion, our studies elucidate the relationship between the size of the conjugated ligand and the catalytic activity of the resultant saccharide conjugated AuNPs (Sac-AuNP) as inversely proportional. Our future research will be focused on large-scale preparation and characterization including its catalytic properties that will be demonstrated to be suitable for the catalytic application to reduce nitrophenol to produce aminophenol. Also during the next funding period, we expect to make significant progress to validate the relationship between the length/size of ligand (monosaccharides to polysaccharides) to catalytic efficiency based on various Sac-AuNPs.

The professional research activity of the PI has tremendously benefited from this grant. During last funding period seven undergraduate students involved in various aspects of this project including synthesize six different Sac-GNPs and characterize them. Students gained firsthand experience in learning and using several analytical techniques including TEM. Within last twelve months, students worked in this project and made presentations in several at national, regional and local conferences including TechConnect World Innovation Conference and Expo, Anaheim CA in May 2018, Spring Chemistry Research Symposium at APSU in Clarksville TN in April 2018, Fall Chemistry Research Symposium at APSU in Clarksville TN in December 2017 and Southeastern Regional Meeting of the American Chemical Society (ACS), Charlotte NC in November 2017. We are now drafting a manuscript for a peer-review journal with the data collected so far with student co-authors.

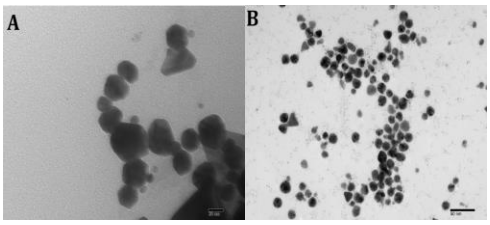

Figure 1: TEM images of (A.) Dex-AuNPs and (B.) Mal-AuNPs with core sizes of 20 nm and 18 nm, respectively. As TEM, imaging is the most thorough way of confirming size, shape, and dispersity of the particles these parameters for synthesis can be said to be optimum as they are the only ones, which have associated images. The Mal-AuNPs show better monodispersion in comparison to the Dex-AuNPs. However, both samples show roughly spherical particles in majority.

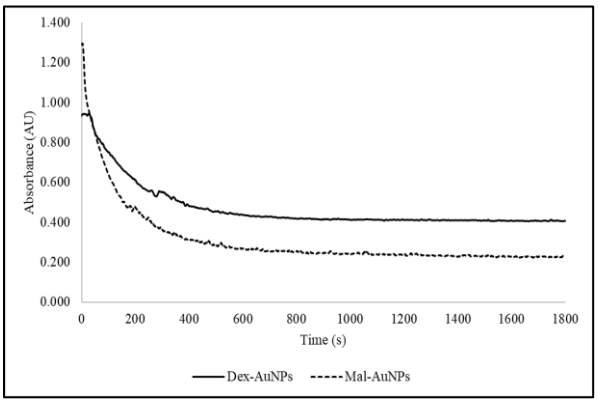

Figure 2: Overlay of the UV-Vis spectroscopic time scans for Dex-, and Mal-AuNPs. Each scan represents the extinction of PNP correlating to a decrease in the absorbance at 400 nm. As this reaction is carried out with $NaBH_4$ in excess the reaction can be modeled as a pseudo-first order reaction and the rate constants for each type of AuNP determined from the respective integrated rate law.