Malemide functionalized magnetites for H_2O_2 sensing

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Magnetic nanoparticles have been extensively explored due to their wide applications ranging from mechanics and engineering to materials design and medicine. The ability to target the particles by mere application of external magnetic field brings ease of handling and hence superiority to the system. Amongst various types of magnetic materials, Fe_3O_4, has been in focus in the domain of bio-nanotechnology due to its biocompatibility and ease of preparation with better control over morphology and size.

With advances in functionalization strategies, attempts to develop a smart system that can selectively detect a particular toxic molecule or reduce its toxicity via some reaction, has opened-up wide scope in development of smart bio-sensors. Hydrogen peroxide (H_2O_2) is one of the strongest oxidizers and causes cellular damage. Detection of H_2O_2 is important from clinical and pathological aspects. Not only that, but it's detection in contaminated water and atmospheric samples has become an important issue because of its use in explosives and wastewater and industrial water treatments. In this context we report on the synthesis and dopamine-maleimide functionalization of Fe_3O_4 nanoparticles for proposed selective detection of hydrogen peroxide using thiol compounds like peroxidase conjugated with gold nanoparticles (AuNP). Dopamine-maleimide molecules are present as self-assembled monolayer (SAM). The core Fe_3O_4 nanoparticles have been synthesized via reverse-coprecipitation route. Phase formation was confirmed with the help of X-ray diffraction. Spherical Fe_3O_4 nanoparticles of the order of 15 nm were seen in the Transmission Electron Microscopy. Dopamine-maleimide as bi-functional linker, containing both catechol group as a Fe_3O_4binding moiety and a reactive group, maleimide, for further interaction with cysteine group was prepared and used for NP functionalization. The conjugation chemistry between the linker and Fe_3O_4 nanoparticles was confirmed with the help of Fourier Transform Infrared Spectroscopy (FTIR). Zeta potential of bare Fe3O4 nanoparticle (22.97 eV) was enhanced after conjugation to the SAM of dopamine-maleimide (35.27 eV), indicating enhanced suspension stability of the later sample. This ensures the maximum of cysteine-maleimide interaction enhancing the sensitivity of the detection. Maleimide has specific binding affinity for thiol group or cysteine. In H_2O_2-Peroxidase

interaction, peroxidase reduces Hydrogen peroxide at its Cysteine residue. In the process cysteine gets reduced, that can not react with maleimide. Further sensing studies based on tracing surface plasmon resonance (SPR) of AuNPs bound to peroxidase and thiolated small peptides will be discussed in detail. .

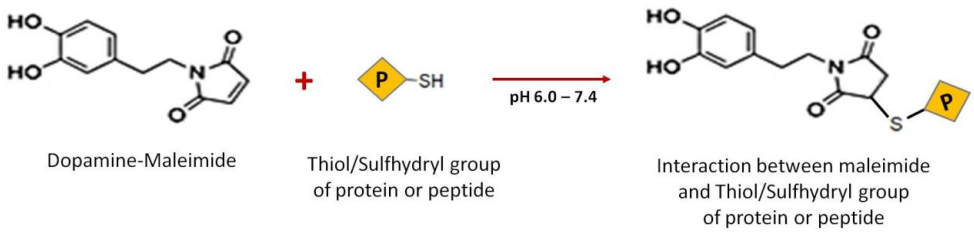

Fig: Molecular structure of the bi-functional linker: Dopamine-maleimide and its interaction with thiol group on protein or peptides