



ME – PhD Thesis Colloquium



Multifunctional Biomaterials based on Polyacrylamide/Hydroxyapatite for magnetic biosensing and Musculoskeletal Repair.

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ABSTRACT

In this work, the possibility of hydrogel based nanocomposites as viable cartilage replacement and in bio-medical devices is explored. For bio-medical usage such as bio-sensors a magnetic composite based on hydrogel is made using chemically induced Nickel nano-particles and diffusion induced Carbon Nano Tubes (CNT). Magnetic nanoparticle based composites are also called Ferrogel. A good and durable bio-sensor should have high magnetic sensitivity, Magnetizability and wear resistance. A comparison of the PAM-Ni-CNT and PAM-Ni Ferrogels with PAM shows that PAM-CNT-Ni based Ferrogel has a 80% increase in its magnetizability owing to the spin transfer effect on CNT carbon atoms in contact with ferromagnetic Ni surface. The PAM-CNT-Ni nanocomposite also shows a higher wear resistance compared to the rest two gels as found from reciprocating friction experiment performed on a tribometer. Using SEM the morphology and distribution on CNTs and Ni- nanoparticles in the gel is detected. XRD and Raman Spectroscopy is used for compositional analysis and phase and crystal size detection of Ni nanoparticles respectively.

The PAM based nanocomposite gel, studied for cartilage replacement, is made using Titanium-oxide and CNTs. The TiO₂ nanoparticles are formed into the gel by diffusion of TiO₂ solution through dried gel. The CNTs are also induced through diffusion. On performing tests for bio-activity and bio-degradation we showed that PAM-TiO₂-CNT based gel has the best bio-compatibility in long terms. Further, on performing experiments like force measurement during needle insertion and compression we find that PAM-TiO₂-CNT gel undergoes the least internal damage during insertion and has the highest compressive strength. Thus, showing the properties required for cartilage replacement. A comparison of PAM-TiO₂-CNT gel to the existent cartilage replacement materials (such as Gelatin) shows former is a more reliable replacement for cartilage.

Hydrogel is a high water absorbing polymer made by polymerizing acrylamide monomers. It's bio-compatibility and high water retaining and absorbing capacity makes it worth exploring in bio-medical field.

ABOUT THE SPEAKER

Jeet Kumar gaur is an integrated PhD student, working in Prof. M S Bobji's (FM) lab, in Mechanical engineering dept of IISc. In his PhD work, he synthesized and studied nanocomposite materials with base as organic polymer (Polyacrylamde) and ceramic (Hydroxyapatite) for magnetic biosensing and musculoskeletal repair applications. The various techniques employed for characterization vary from magnetic hysteresis plot obtained from VSM (Vibrating Sample Magnetometry) to wear rate calculation on a tribometer. While polyacrylamide nanocomposites are viable for soft tissue (like cartilage) replacement, the Hydroxyapatite based nanocomposites are viable for hard tissue like bone-replacement coating material.

