**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI**
**SHORT ABSTRACT OF THESIS**

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| Programme of Study | : | Ph.D. |

Thesis Title:
Cyclic Scavenging of Multi Radicals Using Defect-Induced Zr-doped Nanoceria as Nanofluids and Nanocomposites in Simulated Biological Environment

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| Name of Thesis Supervisor(s) | : | Prof. S. Kanagaraj |
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**SHORT ABSTRACT**

The loss of residual hearing post-cochlear implantation affects about 50% of the current one million users and is the reason for 0.02% revised surgeries of the total 8% revisions, despite various attempts including antioxidant therapy. Though Zr-doped nanoceria presents a potent advancement as a catalyst to effectively scavenge the free radicals such as $O_2^{\bullet-}$ and $OH^{\bullet}$ due to their ability to control the concentration of $Ce^{3+}$ and rate of regeneration, however, its radical scavenging effectiveness under conditions relevant to biological applications are limited to a few compositions only. The objective of this work is to synthesize nanosized defect-induced ceria-zirconia solid solutions and study their multi-radical scavenging and regenerative ability under biological relevant conditions in the form of nanofluid and reinforcement within the silicone elastomer. To achieve the same, $Ce_xZr_{1-x}O_2$ (x=1, 0.8, 0.7, 0.6 and 0.5) nanoparticles are synthesized via co-precipitation method and characterized using suitable methods. Zr doping by 50% in combination with PEG during synthesis process yielded the smallest size (4 nm) of single-phase nanoparticles having the highest concentration of oxygen vacancies accompanied by charge-compensated $Ce^{3+}$, which resulted in a 3-fold enhancement of the oxygen storage capacity and 6-fold enhancement of the hydroxyl radical scavenging, respectively, at a 21% lower dose compared to undoped nanoceria. In addition, the presence of PEG during synthesis

process promoted homogeneous and finer nanoparticles and improved the dispersion stability of nanofluids in water and phosphate buffer solution (PBS) compared to their uncoated counterparts. The PEG coated $Ce_{0.5}Zr_{0.5}O_2$ nanoparticles showed more than 80% of regenerative ability, which is about 20% faster compared to pure nanoceria. Further, the nanoparticles are able to scavenge hydroxyl radical in reinforced state in silicone elastomer matrix without affecting the modulus and electrical conductivity. It is also found that the presence of ions in PBS and perilymph fluid is not found to hinder the scavenging ability of nanoparticles. Based on the study, it is proposed that nanofluid of PEG coated $Ce_{0.5}Zr_{0.5}O_2$ for the direct injections and silicone elastomer/$Ce_{0.5}Zr_{0.5}O_2$ nanocomposites as electrode encasing material can be explored as a potential antioxidant in biological applications, where scavenging of free radicals is desired such as in order to preserve the residual hearing.