**Cell Lysis, labeling efficacy and biodistribution of intravenously administered Technetium-99m labeled Multifunctional Zirconia Nanoparticles in animal model**

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Raman spectroscopy was employed to gain a thorough understanding of the creation of distinct phases. Figure S1 revealed peaks consistent with the tetragonal phase of zirconia. Raman bands of 322 cm-1 and 148 cm-1 for Eg and B1g vibrations agreed with the literature. [1-2].



Figure S1. Raman spectra of as synthesized IOZH nanoparticles at iron oxide content of (a) 5wt. % (b) 6wt. % (c) 7wt. % (d) 8wt. % (e) 9wt. % (f) 10wt. %.



Figure S2: Hardness mapping of samples with iron oxide concentration of (a-d) 1-4 wt%

Real and imaginary impedance values help in obtaining Cole-Cole plots. These plots are used in polycrystalline samples to assess the effect of grains as well as grain boundaries. The Cole-Cole arrangement is made up of three semicircles. High frequency semicircles represent grains, medium frequency semicircles represent grain boundaries, and low frequency semicircles represent the interface between grain boundary/grain and electrode [3]. Eqs. 1 and 2 were used to compute real and imaginary impedance [4].

$Zʹ= \frac{R}{\left[1+\left(ωRC\right)^{2}\right]}$ (1)

$Zʹʹ= \frac{ωR^{2}C}{\left[1+\left(ωRC\right)^{2}\right]}$ (2)





Figure S3. (i) Real, (ii) imaginary impedance and (c) Cole-Cole plots of as synthesized nanoparticles using various concentration of iron oxide (a-j) 1-10wt%

**References**

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