

# Synthetic Cryolite Nanoparticles: A Potential Rare Earth Doped Host Material Capable of Matching the Refractive Index of Numerous Vascularized-Tumor Fluids

Dhawan, Nikhil

Rare-earth-doped nanoparticles (ReNPs) are capable of generating optical emissions for imaging molecular events. ReNPs typically consist of a host material and rare earth dopants. Though serving the function of preventing surface contaminants from attenuating light, the host material is responsible for site-scattering due to a refractive index mismatch with the surrounding medium. Site-scattering contributes to a decrease in ReNP penetration depth, phosphor brightness, and image clarity. The potential of Cryolite ( $\text{Na}_3\text{AlF}_6$ ) as a host material to reduce scattering was investigated by attempting to dope Cryolite with  $\text{Yb}^{3+}$  and  $\text{Er}^{3+}$  using a hydrothermal co-precipitation method and tuning its refractive index to match that of vascularized-tumor fluids. Undoped Cryolite was hydrothermally synthesized using a novel procedure without HF. Field emission scanning electron microscopy and energy-dispersive-X-ray spectroscopy showed that  $\text{Yb}^{3+}$  and  $\text{Er}^{3+}$  were not incorporated into the Cryolite lattice using the hydrothermal co-precipitation method. X-ray diffraction of samples synthesized in acidic and  $\text{Na}^+$  deficient environments indicated the formation of another sodium fluoroaluminate phase, Chiolite ( $\text{Na}_5\text{Al}_3\text{F}_{14}$ ). Rietveld analysis indicated that as the ratio of  $\text{NaOH}:\text{Al}_2\text{O}_3$  in precursor solutions decreased, the % Chiolite in the system increased. Refractive index (N) measurements revealed that as the amount of Chiolite in the sample increased, the refractive index of the system increased, moving towards  $N_{\text{chiolite}}$ . The results demonstrated that the refractive index of the Cryolite/Chiolite system can be tuned between  $[N_{\text{cryolite}}]$  and  $[N_{\text{chiolite}}]$ , showing the feasibility of matching the refractive index of the target biological system and eliminating site-scattering losses ReNPs in-vivo.

## Awards Won:

Fourth Award of \$500