Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

SUPPORTING INFORMATION

$NaBiF_4$: Yb^{3+}, Tm^{3+} submicron particles as luminescent probes for in vitro imaging of cells

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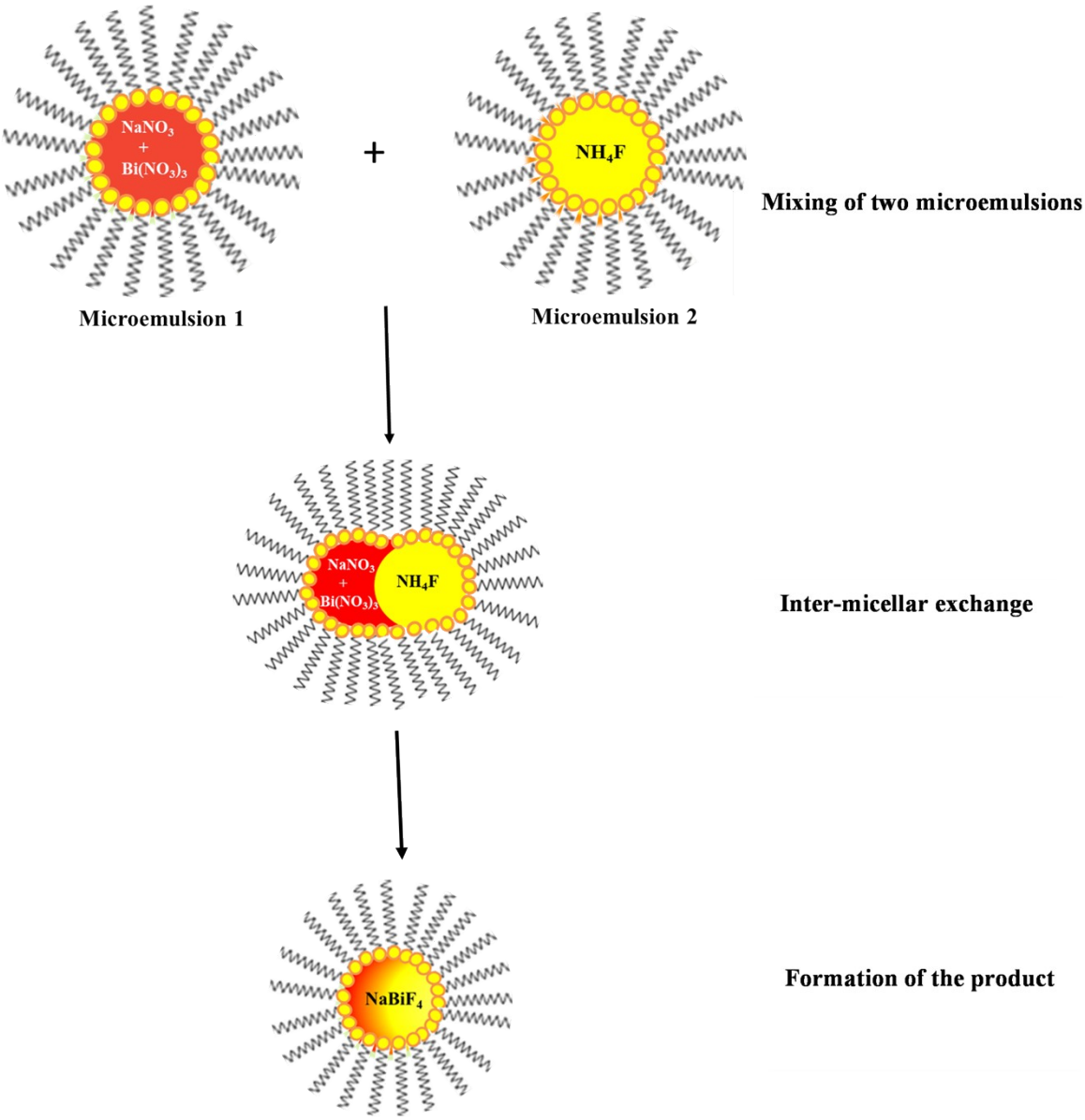
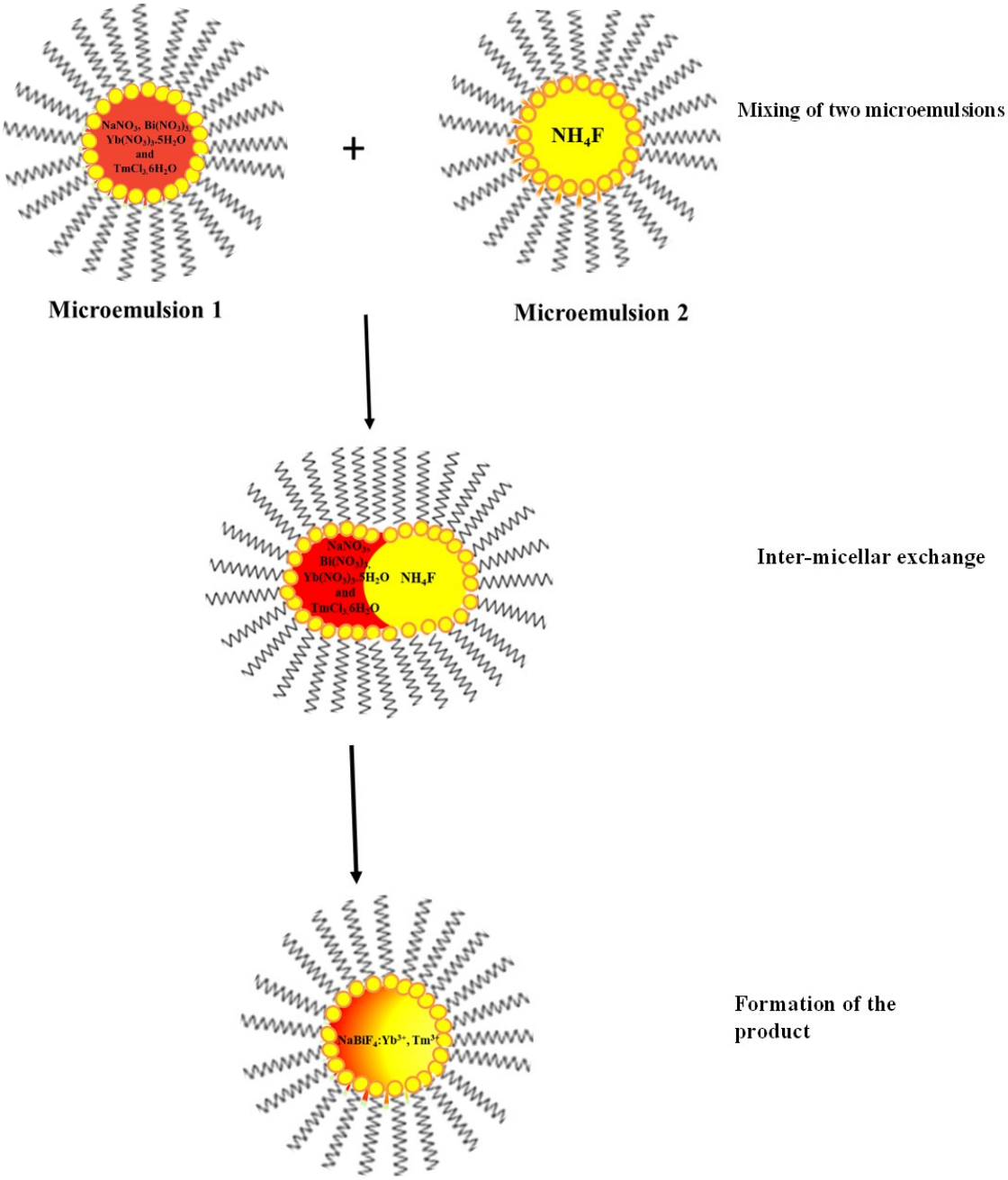
Scheme S1. Mechanism showing the different stages involved in between of product formation.



Scheme S2. Mechanism showing the different stages involved in between of product formation.



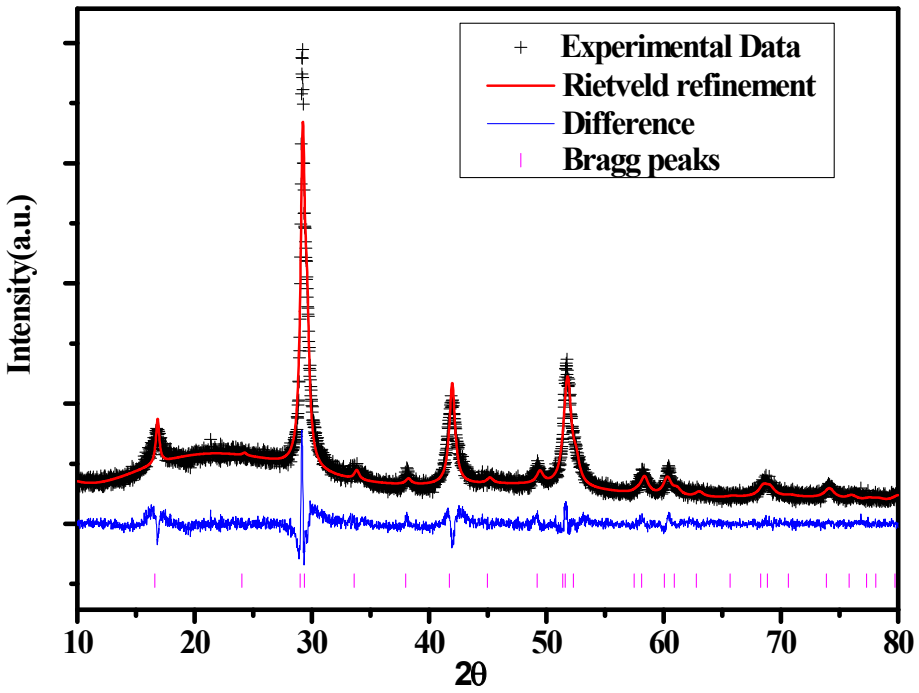


Figure S1. PXRD Rietveld refinement of $NaBiF_4$ submicron particles.

Crystal Structure	Hexagonal
Space Group	$P\bar{3}$
a(Å)	6.1471(14)
c(Å)	3.70176(93)
R_{exp}(%)	6.25
R_p(%)	6.27
R_{wp}	7.88
GOF(S)	1.26

Table S1. Refined positional parameters for hexagonal $NaBiF_4$ submicron particles after the final cycle of refinement.

Refined unit cell is evaluated to be a(Å)= 6.1471(14), c(Å)= 3.70176(93).

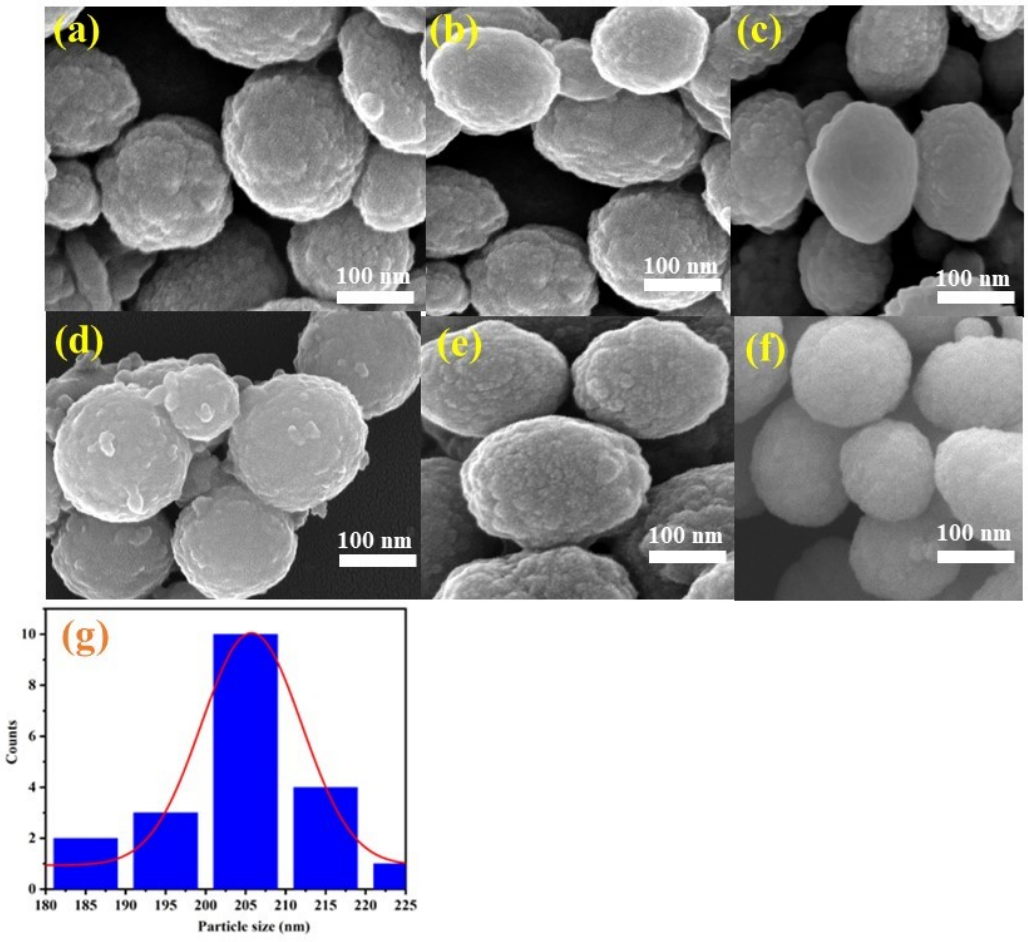


Figure S2. FE -SEM micrographs of (a) $NaBiF_4$ and $NaBiF_4$:Yb^{3+}, Tm^{3+} submicron particles with different concentrations of Tm^{3+} ions (b) 0.5 mol% Tm^{3+}, (c) 1 mol% Tm^{3+}, (d) 2 mol% Tm^{3+}, (e) 3% mol% Tm^{3+}, (f) 4 mol % Tm^{3+} (g) histogram of the particle size distribution with an average size of 205 nm.

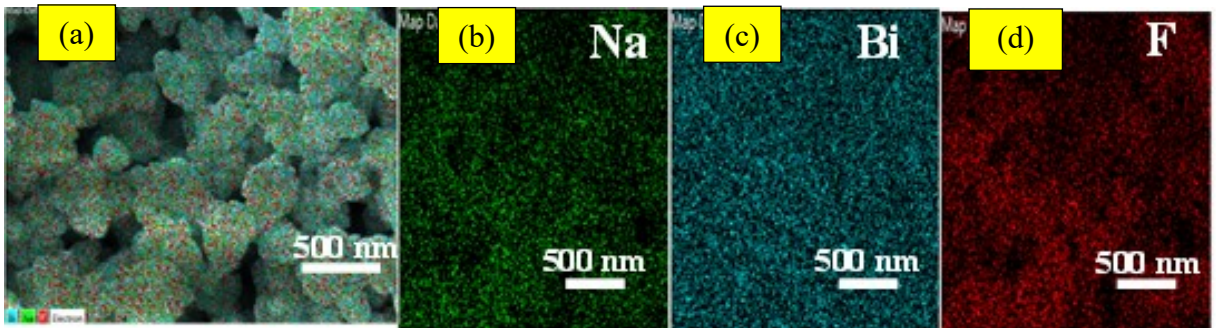


Figure S3. FESEM elemental mapping of $NaBiF_4$ submicron particles showing the presence of elements.

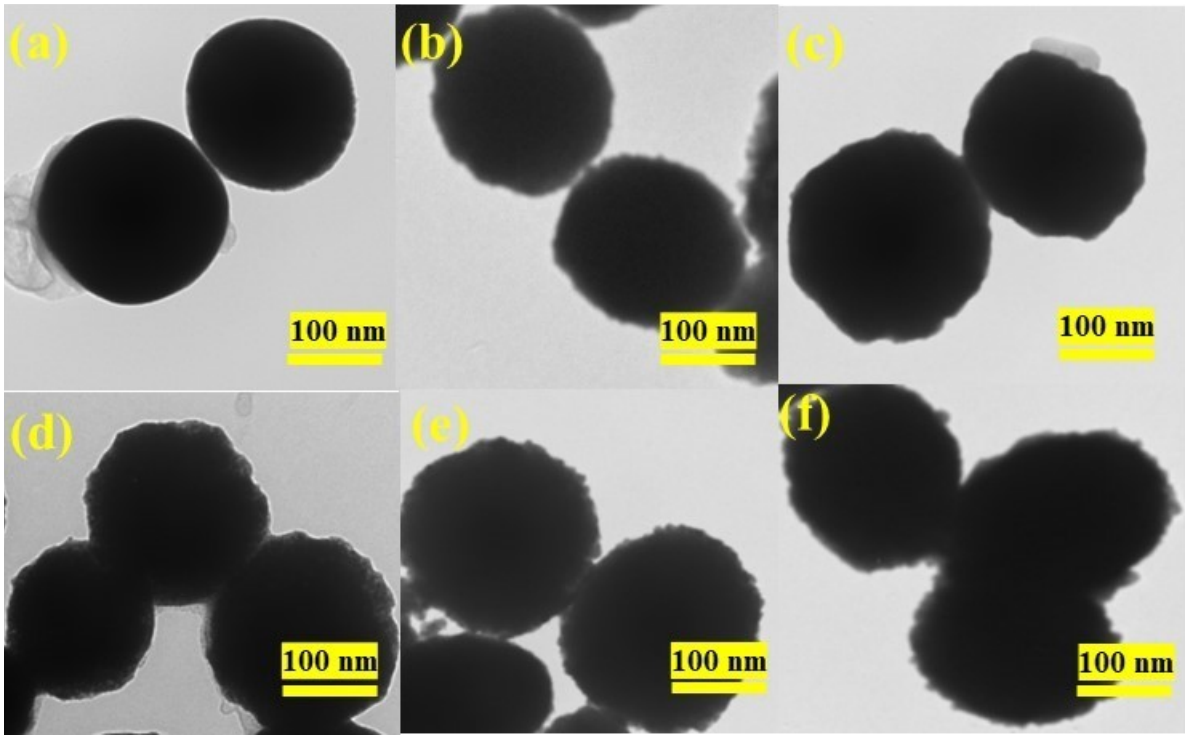


Figure S4. TEM micrographs of (a) $NaBiF_4$ and $NaBiF_4$:Yb^{3+}, Tm^{3+} submicron particles with different concentrations of Tm^{3+} ions (b) 0.5 mol% Tm^{3+}, (c) 1 mol% Tm^{3+}, (d) 2 mol% Tm^{3+}, (e) 3% mol% Tm^{3+}, (f) 4 mol % Tm^{3+}

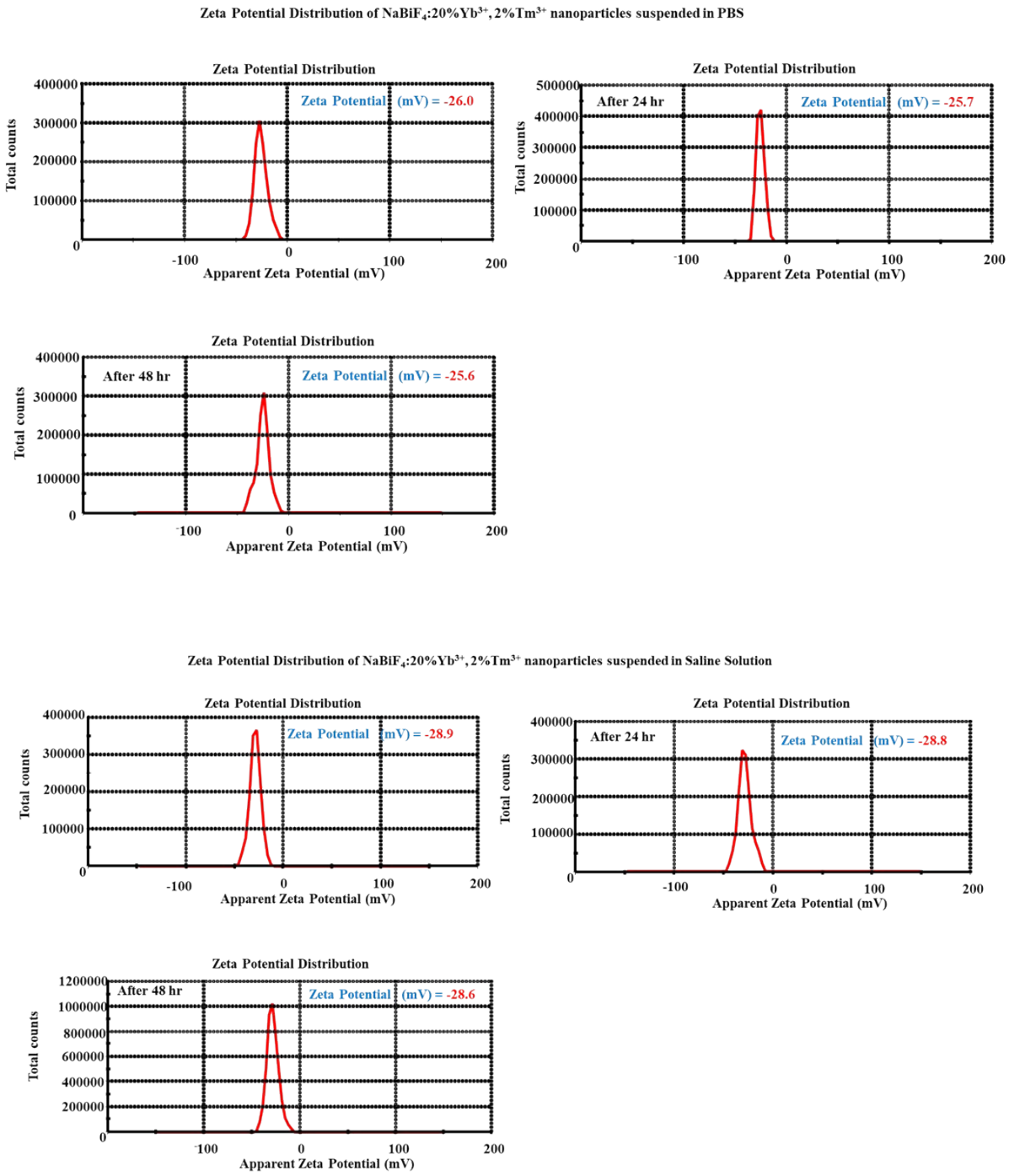


Figure S5. Zeta Potential of $NaBiF_4$: 20%Yb^{3+}, 2% Tm^{3+} submicron particles suspended in PBS and 0.9% NaCl saline solution.

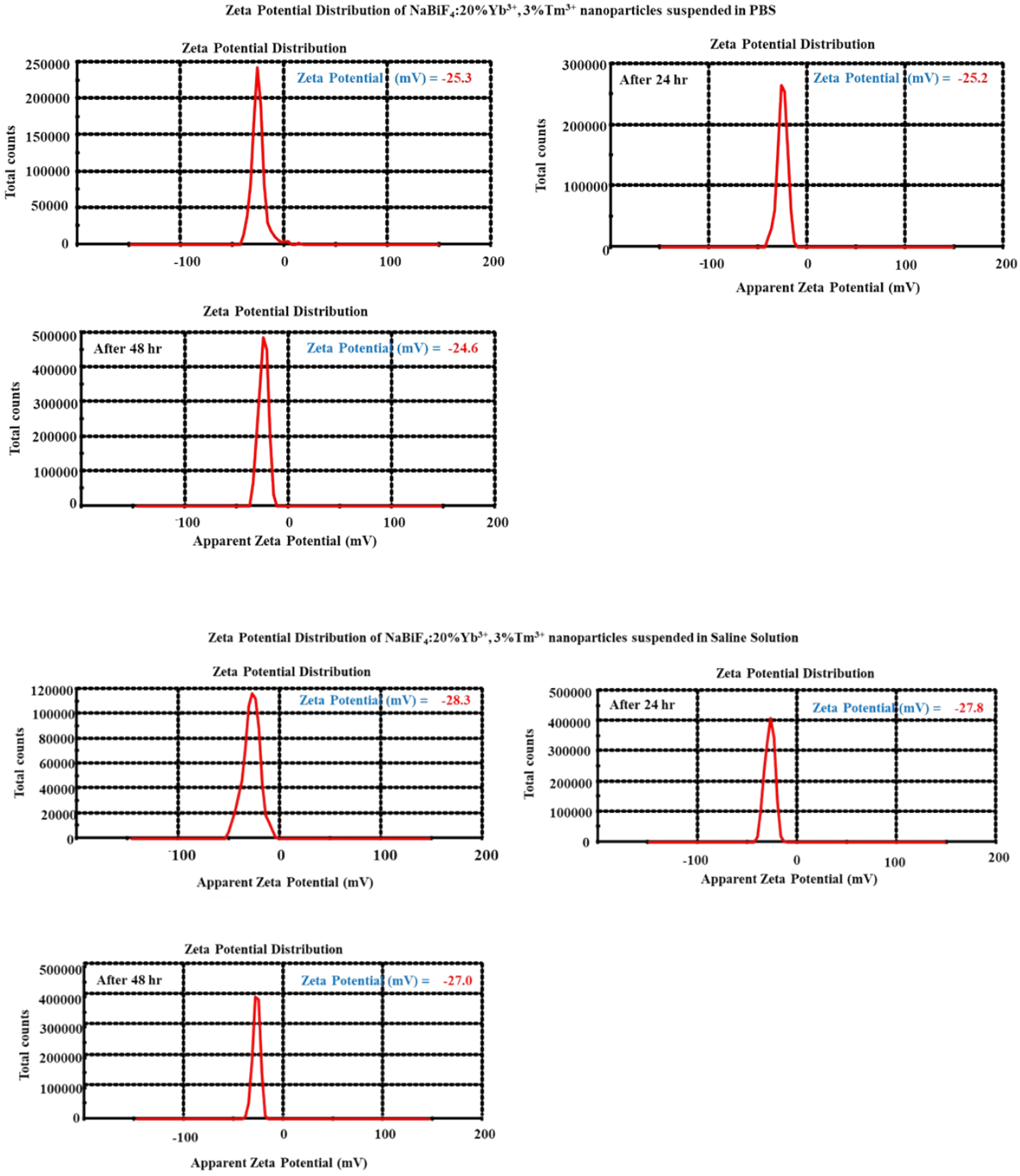


Figure S6. Zeta Potential of $NaBiF_4$: 20%Yb^{3+}, 3% Tm^{3+} nanoparticles suspended in PBS and 0.9% NaCl saline solution.

Quantum yield

Quantum yield is defined as the ratio of the number of photons emitted to the number of photons absorbed. All measurements were performed using a diode laser with excitation power of 100 mW at a wavelength of 980 nm. The quantum yield of samples has been estimated by standard method using an integrating sphere equipped with an optical fiber-based optics indigenously designed set-up using spectrophotometer. To measure quantum yield first the spectrum of 980 nm excitation source was recorded in order to check the scattering of light (radiant flux) without sample and further the powder sample was placed in a quartz cell to estimate the emitted blue light (integrated fraction of luminous flux for blue) upon 980nm diode laser as excitation source for transition $^1D_2$–$^3F_4$ & $^1G_4$-$^3H_6$. The experiment was repeated several times for all samples and statistical performances of experiment have shown in Table S2. The obtained values are based on evaluation of quantum yield using the standard method of measuring the integrated fraction of luminous flux and radiant flux.

Table S2: Quantum yield of $NaBiF_4$: 20%Yb^{3+}, (0.5 - 4%) Tm^{3+}

Sample	**Quantum yield (%)**	**Transitions covered**	**Emission wavelength covered**
$NaBiF_4$:20%Yb^{3+},0.5%Tm^{3+}	0.07	$^1D_2$ – $^3F_4$ & $^1G_4$ - $^3H_6$	450 nm & 474 nm
$NaBiF_4$: 20%Yb^{3+}, 1%Tm^{3+}	0.23	$^1D_2$ – $^3F_4$ & $^1G_4$ - $^3H_6$	450 nm & 474 nm
$NaBiF_4$: 20%Yb^{3+}, 2%Tm^{3+}	0.31	$^1D_2$ – $^3F_4$ & $^1G_4$ - $^3H_6$	450 nm & 474 nm
$NaBiF_4$: 20%Yb^{3+}, 3%Tm^{3+}	0.38	$^1D_2$ – $^3F_4$ & $^1G_4$ - $^3H_6$	450 nm & 474 nm
$NaBiF_4$: 20%Yb^{3+}, 4%Tm^{3+}	0.17	$^1D_2$ – $^3F_4$ & $^1G_4$ - $^3H_6$	450 nm & 474 nm