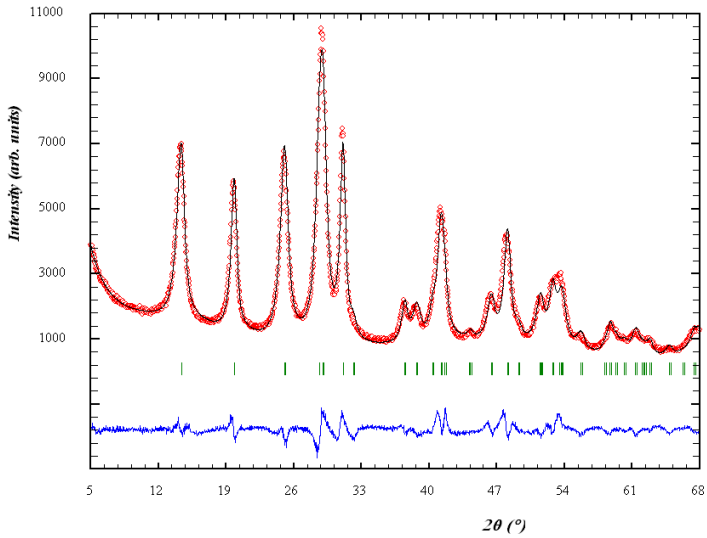
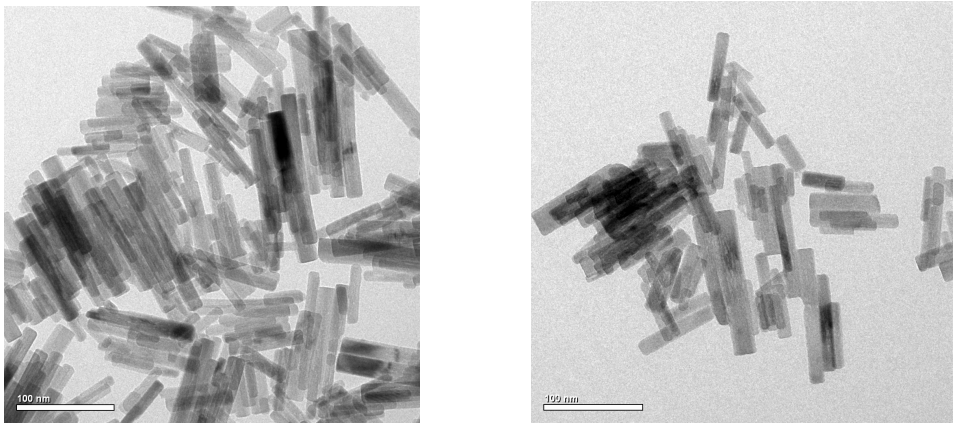
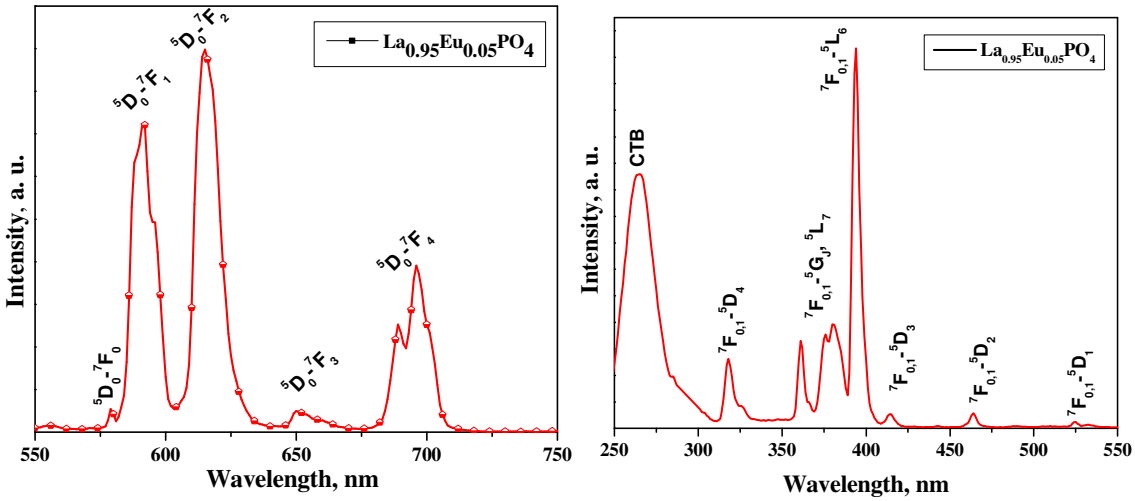
Supporting Information for the Publication



Data S1a: Reitveld refined XRD pattern of the $La_{0.95}Eu_{0.05}PO_4$ nanorods



Data S1b: TEM pictures of the $La_{0.95}Eu_{0.05}PO_4$ nanorods



Data S1c: Emission (λ_{ex} = 393 nm) and excitation (λ_{em} = 588 nm) spectra of the $La_{0.95}Eu_{0.05}PO_4$ nanorods

IR (ATR; ν [cm^{-1}]): 3270, 2953, 2818, 1658, 1597, 1458, 1302, 1118, 1054, 1008, 917, 768, 517. ^{1}H-NMR (D_2O, δ/ppm): 2.25 – 2.90 (br, D-C*H*$_2$-CH$_2$-D, D-C*H*$_2$-CH$_2$-L, D-C*H*$_2$-CH$_2$-T, L-C*H*$_2$-CH$_2$-D, L-C*H*$_2$-CH$_2$-L, L-C*H*$_2$-CH$_2$-T, T-C*H*$_2$-CH$_2$-D, T-C*H*$_2$-CH$_2$-L), 3.22 (s, 9H, N(C*H*$_3$)$_3$), 3.45 – 3.50 (br, 4H, -C*H*$_2$-N(CH$_3$)$_3$), -RN-C*H*$_2$-CHOH-), 4.20 – 4.45 (br, 1H, CH$_2$-C*H*OH-CH$_2$-). ^{13}C-NMR (D_2O, δ/ppm): 37.8 (NH$_2$-*C*H$_2$-CH$_2$-D), 39.9 (NH$_2$-*C*H$_2$-CH$_2$-L), 45.5 (L-*C*H$_2$-CH$_2$-D), 47.7 (L-*C*H$_2$-CH$_2$-L), 50.6 (L-*C*H$_2$-CH$_2$-NH$_2$), 52.0 (D-*C*H$_2$-CH$_2$-D), 53.1 (D-*C*H$_2$-CH$_2$-L), 54.3 (-N(*C*H$_3$)$_3$), 56.6 (D-CH$_2$CH$_2$-NH$_2$), 63.7 (L-*C*H$_2$-CHOH-), 64.8 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 66.5 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 68.4 (T-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 69.3 (L-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 73.2 (D-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$). Elemental analysis found (calc. for $[C_2H_4N]_{1-x}[C_8H_{19}ClN_2O]_x$, x=0.15): C: 46.99 (54.54); H: 11.06(11.34); N: 21.43(29.04).

Data S2. The IR, ^{1}H-NMR, ^{13}C-NMR and elemental analysis results of Quat-Primer polymer $PEI_{0.423K}^{5Q}$ (1)

IR (ATR; ν [cm^{-1}]): 3255 (br), 2932, 2811, 1616, 1473, 1457, 1362, 1298, 1112, 1010, 965, 722, 601. ^{1}H-NMR (D_2O, δ/ppm): 2.45 – 2.90 (br, D-C*H*$_2$-CH$_2$-D, D-C*H*$_2$-CH$_2$-L, D-C*H*$_2$-CH$_2$-T, L-C*H*$_2$-CH$_2$-D, L-C*H*$_2$-CH$_2$-L, L-C*H*$_2$-CH$_2$-T, T-C*H*$_2$-CH$_2$-D, T-C*H*$_2$-CH$_2$-L), 3.32 (s, 9H, N(C*H*$_3$)$_3$), 3.45 – 3.60 (br, 4H, -C*H*$_2$-N(CH$_3$)$_3$), -RN-C*H*$_2$-CHOH-), 4.30 – 4.55 (br, 1H, CH$_2$-C*H*OH-CH$_2$-). ^{13}C-NMR (D_2O, δ/ppm): 37.9 (NH$_2$-*C*H$_2$-CH$_2$-D), 39.9 (NH$_2$-*C*H$_2$-CH$_2$-L), 45.7 (L-*C*H$_2$-CH$_2$-D), 47.8 (L-*C*H$_2$-CH$_2$-L), 50.6 (L-*C*H$_2$-CH$_2$-NH$_2$), 52.0 (D-*C*H$_2$-CH$_2$-D), 53.2 (D-*C*H$_2$-CH$_2$-L), 54.3 (-N(*C*H$_3$)$_3$), 56.1 (D-CH$_2$CH$_2$-NH$_2$), 63.7 (L-*C*H$_2$-CHOH-), 64.8 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 66.5 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 68.3 (T-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 69.3 (L-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 73.3 (D-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$).

Elemental analysis found (calc. for $[C_2H_4N]_{1-x}[C_8H_{19}ClN_2O]_x$, x=0.15): C: 46.99 (52.92); H: 11.06(10.87); N: 21.43(24.47).

Data S3: The IR, ^{1}H-NMR, ^{13}C-NMR and elemental analysis results of Quat-Primer polymer $PEI_{0.423K}^{15Q}$ (2).

IR (ATR; ν [cm^{-1}]): 3246 (br), 2933, 2816, 1636, 1474, 1457, 1362, 1297, 1106, 1010, 966, 919, 601. ^{1}H-NMR (D_2O, δ/ppm): 2.50 – 2.90 (br, D-C*H*$_2$-CH$_2$-D, D-C*H*$_2$-CH$_2$-L, D-C*H*$_2$-CH$_2$-T, L-C*H*$_2$-CH$_2$-D, L-C*H*$_2$-CH$_2$-L, L-C*H*$_2$-CH$_2$-T, T-C*H*$_2$-CH$_2$-D, T-C*H*$_2$-CH$_2$-L), 3.32 (s, 9H, N(C*H*$_3$)$_3$), 3.45 – 3.60 (br, 4H, -C*H*$_2$-N(CH$_3$)$_3$), -RN-C*H*$_2$-CHOH-), 4.30 – 4.55 (br, 1H, CH$_2$-C*H*OH-CH$_2$-). ^{13}C-NMR (D_2O, δ/ppm): 37.7 (NH$_2$-*C*H$_2$-CH$_2$-D), 39.7 (NH$_2$-*C*H$_2$-CH$_2$-L), 45.5 (L-*C*H$_2$-CH$_2$-D), 47.6 (L-*C*H$_2$-CH$_2$-L), 50.4 (L-*C*H$_2$-CH$_2$-NH$_2$), 51.8 (D-*C*H$_2$-CH$_2$-D), 53.0 (D-*C*H$_2$-CH$_2$-L), 54.1 (-N(*C*H$_3$)$_3$), 56.4 (D-CH$_2$CH$_2$-NH$_2$), 63.6 (L-*C*H$_2$-CHOH-), 64.8 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 66.3 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 68.2 (T-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 69.1 (L-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 73.2 (D-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$). Elemental analysis: found (calc. for $[C_2H_4N]_{1-x}[C_8H_{19}ClN_2O]_x$, x=0.3): C: 45.72 (51.54); H: 11.08 (10.47); N: 18.05 (20.56).

Data S4: The IR, ^{1}H-NMR, ^{13}C-NMR and elemental analysis results Quat-Primer polymer $PEI_{0.423K}^{30Q}$ (3).

IR (ATR; ν [cm^{-1}]): 3267, 2931, 2883, 2808, 1595, 1454, 1353, 1293, 1111, 1048, 908, 761. ^{1}H-NMR (D_2O, δ/ppm): 2.45 – 2.90 (br, D-C*H*$_2$-CH$_2$-D, D-C*H*$_2$-CH$_2$-L, D-C*H*$_2$-CH$_2$-T, L-C*H*$_2$-CH$_2$-D, L-C*H*$_2$-CH$_2$-L, L-C*H*$_2$-CH$_2$-T, T-C*H*$_2$-CH$_2$-D, T-C*H*$_2$-CH$_2$-L), 3.24 (s, 9H, N(C*H*$_3$)$_3$), 3.35 – 3.55 (br, 4H, -C*H*$_2$-N(CH$_3$)$_3$), -RN-C*H*$_2$-CHOH-), 4.20 – 4.50 (br, 1H, CH$_2$-C*H*OH-CH$_2$-). ^{13}C-NMR (D_2O, δ/ppm): 37.9 (NH$_2$-*C*H$_2$-CH$_2$-D), 39.9 (NH$_2$-*C*H$_2$-CH$_2$-L), 45.6 (L-*C*H$_2$-CH$_2$-D), 47.8 (L-*C*H$_2$-CH$_2$-L), 50.7 (L-*C*H$_2$-CH$_2$-NH$_2$), 51.2 (D-*C*H$_2$-CH$_2$-D), 53.2 (D-*C*H$_2$-CH$_2$-L), 54.3 (-N(*C*H$_3$)$_3$), 56.6 (D-CH$_2$CH$_2$-NH$_2$), 63.7 (L-*C*H$_2$-CHOH-), 64.8 (-

*C*HOH-CH_2-N(CH_3)$_3$), 66.5 (-*C*HOH-CH_2-N(CH_3)$_3$), 68.4 (T-CH_2-CHOH-*C*H_2-N(CH_3)$_3$), 69.3 (L-CH_2-CHOH-*C*H_2-N(CH_3)$_3$), 73.4 (D-CH_2-CHOH-*C*H_2-N(CH_3)$_3$). Elemental analysis: found (calc. for $[C_2H_4N]_{1-x}[C_8H_{19}ClN_2O]_x$, x=0.15): C: 51.84 (54.54); H: 11.54 (11.34); N: 28.72 (29.04).

Data S5: The IR, ^{1}H-NMR, ^{13}C-NMR and elemental analysis results of Quat-Primer polymer $PEI_{1.2K}^{5Q}$ (4).

IR (ATR; ν [cm^{-1}]): 3276, 2951, 2842, 1646, 1474, 1306, 1104, 1050, 963, 917, 510. ^{1}H-NMR (D_2O, δ/ppm): 2.60 – 2.90 (br, D-C*H*$_2$-CH_2-D, D-C*H*$_2$-CH_2-L, D-C*H*$_2$-CH_2-T, L-C*H*$_2$-CH_2-D, L-C*H*$_2$-CH_2-L, L-C*H*$_2$-CH_2-T, T-C*H*$_2$-CH_2-D, T-C*H*$_2$-CH_2-L), 3.27 (s, 9H, N(C*H*$_3$)$_3$), 3.45 – 3.60 (br, 4H, -C*H*$_2$-N(CH_3)$_3$), -RN-C*H*$_2$-CHOH-), 4.30 – 4.60 (br, 1H, CH_2-C*H*OH-CH_2-). ^{13}C-NMR (D_2O, δ/ppm): 37.9 (NH_2-*C*H_2-CH_2-D), 39.9 (NH_2-*C*H_2-CH_2-L), 45.6 (L-*C*H_2-CH_2-D), 47.8 (L-*C*H_2-CH_2-L), 50.6 (L-*C*H_2-CH_2-NH_2), 51.2 (D-*C*H_2-CH_2-D), 53.2 (D-*C*H_2-CH_2-L), 54.3 (-N(*C*H_3)$_3$), 56.2 (D-CH_2CH_2-NH_2), 63.7 (L-*C*H_2-CHOH-), 64.8 (-*C*HOH-CH_2-N(CH_3)$_3$), 66.5 (-*C*HOH-CH_2-N(CH_3)$_3$), 68.4 (T-CH_2-CHOH-*C*H_2-N(CH_3)$_3$), 69.3 (L-CH_2-CHOH-*C*H_2-N(CH_3)$_3$), 73.4 (D-CH_2-CHOH-*C*H_2-N(CH_3)$_3$). Elemental analysis: found (calc. for $[C_2H_4N]_{1-x}[C_8H_{19}ClN_2O]_x$, x=0.15): C: 48.09 (52.92); H: 11.38 (10.87); N: 22.27 (24.47).

Data S6: The IR, ^{1}H-NMR, ^{13}C-NMR and elemental analysis results of Quat-Primer polymer $PEI_{1.2K}^{15Q}$ (5).

IR (ATR; ν [cm^{-1}]): 3249, 2931, 2818, 1599, 1476, 1358, 1296, 1102, 1057, 966, 941, 917, 760, 560. ^{1}H-NMR (D_2O, δ/ppm): 2.60 – 3.00 (br, D-C*H*$_2$-CH_2-D, D-C*H*$_2$-CH_2-L, D-C*H*$_2$-CH_2-T, L-C*H*$_2$-CH_2-D, L-C*H*$_2$-CH_2-L, L-C*H*$_2$-CH_2-T, T-C*H*$_2$-CH_2-D, T-C*H*$_2$-CH_2-L), 3.30 (s, 9H, N(C*H*$_3$)$_3$), 3.45 – 3.60 (br, 4H, -C*H*$_2$-N(CH_3)$_3$), -RN-C*H*$_2$-CHOH-), 4.30 – 4.60 (br, 1H, CH_2-C*H*OH-CH_2-). ^{13}C-NMR (D_2O, δ/ppm): 37.9 (NH_2-*C*H_2-CH_2-D), 39.9 (NH_2-*C*H_2-CH_2-

L), 45.7 (L-*C*H_2-CH_2-D), 47.8 (L-*C*H_2-CH_2-L), 50.5 (L-*C*H_2-CH_2-NH_2), 51.2 (D-*C*H_2-CH_2-D), 53.2 (D-*C*H_2-CH_2-L), 54.4 (-N(*C*H_3)$_3$), 56.0 (D-CH_2CH_2-NH_2), 63.8 (L-*C*H_2-CHOH-), 64.8 (-*C*HOH-CH_2-N(CH_3)$_3$), 66.5 (-*C*HOH-CH_2-N(CH_3)$_3$), 68.4 (T-CH_2-CHOH-*C*H_2-N(CH_3)$_3$), 69.3 (L-CH_2-CHOH-*C*H_2-N(CH_3)$_3$), 73.3 (D-CH_2-CHOH-*C*H_2-N(CH_3)$_3$). Elemental analysis: found (calc. for $[C_2H_4N]_{1-x}[C_8H_{19}ClN_2O]_x$, x=0.3): C: 45.61 (51.54); H: 10.55 (10.47); N: 18.30 (20.56).

Data S7: The IR, ^{1}H-NMR, ^{13}C-NMR and elemental analysis results of Quat-Primer polymer $PEI_{1.2K}^{30Q}$ (6)

IR (ATR; ν [cm^{-1}]): 3261, 2932, 2810, 1576, 1457, 1296, 1105, 1050, 917, 759, 600. ^{1}H-NMR (D_2O, δ/ppm): 2.50 – 3.00 (br, D-C*H*$_2$-CH_2-D, D-C*H*$_2$-CH_2-L, D-C*H*$_2$-CH_2-T, L-C*H*$_2$-CH_2-D, L-C*H*$_2$-CH_2-L, L-C*H*$_2$-CH_2-T, T-C*H*$_2$-CH_2-D, T-C*H*$_2$-CH_2-L), 3.32 (s, 9H, N(C*H*$_3$)$_3$), 3.45 – 3.60 (br, 4H, -C*H*$_2$-N(CH_3)$_3$), -RN-C*H*$_2$-CHOH-), 4.30 – 4.60 (br, 1H, CH_2-C*H*OH-CH_2-).^{13}C-NMR (D_2O, δ/ppm): 37.9 (NH_2-*C*H_2-CH_2-D), 39.9 (NH_2-*C*H_2-CH_2-L), 45.7 (L-*C*H_2-CH_2-D), 47.7 (L-*C*H_2-CH_2-L), 50.6 (L-*C*H_2-CH_2-NH_2), 51.2 (D-*C*H_2-CH_2-D), 53.2 (D-*C*H_2-CH_2-L), 54.3 (-N(*C*H_3)$_3$), 55.8 (D-CH_2CH_2-NH_2), 63.7 (L-*C*H_2-CHOH-), 64.1 (T-(*C*H_2-CHOH-CH_2-N(CH_3)$_3$)$_2$), 65.0 (-*C*HOH-CH_2-N(CH_3)$_3$), 66.5 (-*C*HOH-CH_2-N(CH_3)$_3$), 68.3 (T-CH_2-CHOH-*C*H_2-N(CH_3)$_3$), 69.3 (L-CH_2-CHOH-*C*H_2-N(CH_3)$_3$), 73.3 (D-CH_2-CHOH-*C*H_2-N(CH_3)$_3$). Elemental analysis: found (calc. for $[C_2H_4N]_{1-x}[C_8H_{19}ClN_2O]_x$, x=0.15): C: 48.76 (54.54); H: 11.32 (11.34); N: 25.38 (29.04).

Data S8. The IR, ^{1}H-NMR, ^{13}C-NMR and elemental analysis results of Quat-Primer polymer PEI_{10K}^{5Q} (7)

IR (ATR; ν [cm^{-1}]): 3254, 2933, 2813, 1577, 1458, 1352, 1297, 1105, 1054, 966, 918, 759, 571. ^{1}H-NMR (D_2O, δ/ppm): 2.45 – 2.80 (br, D-C*H*$_2$-CH_2-D, D-C*H*$_2$-CH_2-L, D-C*H*$_2$-CH_2-T, L-C*H*$_2$-CH_2-D, L-C*H*$_2$-CH_2-L, L-C*H*$_2$-CH_2-T, T-C*H*$_2$-CH_2-D, T-C*H*$_2$-CH_2-L), 3.23 (s, 9H,

N(C*H*$_3$)$_3$), 3.35 – 3.50 (br, 4H, -C*H*$_2$-N(CH$_3$)$_3$), -RN-C*H*$_2$-CHOH-), 4.25 – 4.50 (br, 1H, CH$_2$-C*H*OH-CH$_2$-). ^{13}C-NMR (D$_2$O, δ/ppm): 37.9 (NH$_2$-*C*H$_2$-CH$_2$-D), 39.9 (NH$_2$-*C*H$_2$-CH$_2$-L), 45.7 (L-*C*H$_2$-CH$_2$-D), 47.8 (L-*C*H$_2$-CH$_2$-L), 50.6 (L-*C*H$_2$-CH$_2$-NH$_2$), 51.2 (D-*C*H$_2$-CH$_2$-D), 53.2 (D-*C*H$_2$-CH$_2$-L), 54.3 (-N(*C*H$_3$)$_3$), 55.9 (D-CH$_2$CH$_2$-NH$_2$), 63.7 (L-*C*H$_2$-CHOH-), 64.1 (T-(*C*H$_2$-CHOH-CH$_2$-N(CH$_3$)$_3$)$_2$), 65.1 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 66.5 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 68.3 (T-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 69.3 (L-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 73.3 (D-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$). Elemental analysis: found (calc. for [C$_2$H$_4$N]$_{1-x}$[C$_8$H$_{19}$ClN$_2$O]$_x$, x=0.15): C: 43.72 (52.92); H: 10.91 (10.87); N: 20.06 (24.47).

Data S9: The IR, ^{1}H-NMR, ^{13}C-NMR and elemental analysis results of Quat-Primer Polymer PEI$_{10K}^{15Q}$ (8)

IR (ATR; ν [cm^{-1}]): 3253, 2927, 2823, 1601, 1475, 1362, 1298, 1101, 1056, 965, 918, 758, 483. ^{1}H-NMR (D$_2$O, δ/ppm): 2.45 – 2.85 (br, D-C*H*$_2$-CH$_2$-D, D-C*H*$_2$-CH$_2$-L, D-C*H*$_2$-CH$_2$-T, L-C*H*$_2$-CH$_2$-D, L-C*H*$_2$-CH$_2$-L, L-C*H*$_2$-CH$_2$-T, T-C*H*$_2$-CH$_2$-D, T-C*H*$_2$-CH$_2$-L), 3.24 (s, 9H, N(C*H*$_3$)$_3$), 3.35 – 3.50 (br, 4H, -C*H*$_2$-N(CH$_3$)$_3$), -RN-C*H*$_2$-CHOH-), 4.25 – 4.50 (br, 1H, CH$_2$-C*H*OH-CH$_2$-). ^{13}C-NMR (D$_2$O, δ/ppm): 37.9 (NH$_2$-*C*H$_2$-CH$_2$-D), 39.8 (NH$_2$-*C*H$_2$-CH$_2$-L), 45.7 (L-*C*H$_2$-CH$_2$-D), 47.8 (L-*C*H$_2$-CH$_2$-L), 50.4 (L-*C*H$_2$-CH$_2$-NH$_2$), 51.2 (D-*C*H$_2$-CH$_2$-D), 53.2 (D-*C*H$_2$-CH$_2$-L), 54.3 (-N(*C*H$_3$)$_3$), 55.7 (D-CH$_2$CH$_2$-NH$_2$), 63.7 (L-*C*H$_2$-CHOH-), 64.1 (T-(*C*H$_2$-CHOH-CH$_2$-N(CH$_3$)$_3$)$_2$), 65.0 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 66.5 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 68.3 (T-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 69.3 (L-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 73.3 (D-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$). Elemental analysis: found (calc. for [C$_2$H$_4$N]$_{1-x}$[C$_8$H$_{19}$ClN$_2$O]$_x$, x=0.3): C: 46.32 (51.54); H: 10.54 (10.47); N: 17.84 (20.56).

Data S10. The IR, ^{1}H-NMR, ^{13}C-NMR and elemental analysis results of Quat-Primer polymer PEI$_{10K}^{30Q}$ (9)

IR (ATR; ν [cm^{-1}]): 3234, 2955, 2826, 2361, 2341, 1636, 1559, 1475, 1098, 1056, 965, 918, 503. ^{1}H-NMR (D$_2$O, δ/ppm): 2.55 – 2.95 (br, D-C*H*$_2$-CH$_2$-D, D-C*H*$_2$-CH$_2$-L, D-C*H*$_2$-CH$_2$-T,

L-C*H*$_2$-CH$_2$-D, L-C*H*$_2$-CH$_2$-L, L-C*H*$_2$-CH$_2$-T, T-C*H*$_2$-CH$_2$-D, T-C*H*$_2$-CH$_2$-L), 3.35 (s, 9H, N(C*H*$_3$)$_3$), 3.45 – 3.60 (br, 4H, -C*H*$_2$-N(CH$_3$)$_3$), -RN-C*H*$_2$-CHOH-), 4.30 – 4.55 (br, 1H, CH$_2$-C*H*OH-CH$_2$-).

^{13}C-NMR (D$_2$O, δ/ppm): 45.7 (L-*C*H$_2$-CH$_2$-D), 47.7 (L-*C*H$_2$-CH$_2$-L), 51.2 (D-*C*H$_2$-CH$_2$-D), 53.0 (D-*C*H$_2$-CH$_2$-L), 54.3 (-N(*C*H$_3$)$_3$), 63.7 (L-*C*H$_2$-CHOH-), 64.1 (T-(*C*H$_2$-CHOH-CH$_2$-N(CH$_3$)$_3$)$_2$), 64.9 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 66.4 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 68.3 (T-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 69.2 (L-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 73.3 (D-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$). Elemental analysis: found (calc. for [C$_2$H$_4$N]$_{1-x}$[C$_8$H$_{19}$ClN$_2$O]$_x$, x=0.5): C: 43.04 (50.51); H: 10.80 (10.17); N: 15.11 (17.67).

Data S11. The IR, ^{1}H-NMR, ^{13}C-NMR and elemental analysis results of Quat-Primer polymer PEI$_{10K}^{50Q}$ (10)

IR (ATR; ν [cm^{-1}]): 3233, 3012, 2947, 2824, 2361, 2341, 1636, 1559, 1475, 1362, 1290, 1099, 1057, 965, 918, 526. ^{1}H-NMR (D$_2$O, δ/ppm): 2.60 – 2.95 (br, D-C*H*$_2$-CH$_2$-D, D-C*H*$_2$-CH$_2$-L, D-C*H*$_2$-CH$_2$-T, L-C*H*$_2$-CH$_2$-D, L-C*H*$_2$-CH$_2$-L, L-C*H*$_2$-CH$_2$-T, T-C*H*$_2$-CH$_2$-D, T-C*H*$_2$-CH$_2$-L), 3.35 (s, 9H, N(C*H*$_3$)$_3$), 3.45 – 3.60 (br, 4H, -C*H*$_2$-N(CH$_3$)$_3$), -RN-C*H*$_2$-CHOH-), 4.30 – 4.55 (br, 1H, CH$_2$-C*H*OH-CH$_2$-). ^{13}C-NMR (D$_2$O, δ/ppm): 45.7 (L-*C*H$_2$-CH$_2$-D), 47.4 (L-*C*H$_2$-CH$_2$-L), 51.6 (D-*C*H$_2$-CH$_2$-D), 53.0 (D-*C*H$_2$-CH$_2$-L), 54.4 (-N(*C*H$_3$)$_3$), 63.7 (L-*C*H$_2$-CHOH-), 64.2 (T-(*C*H$_2$-CHOH-CH$_2$-N(CH$_3$)$_3$)$_2$), 64.9 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 66.5 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 68.3 (T-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 69.3 (L-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 73.3 (D-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$). Elemental analysis: found (calc. for [C$_2$H$_4$N]$_{1-x}$[C$_8$H$_{19}$ClN$_2$O]$_x$, x=0.75): C: 44.89 (49.79); H: 10.23 (9.96); N: 14.13 (15.63).

Data S12. The IR, ^{1}H-NMR, ^{13}C-NMR and elemental analysis results of Quat-Primer polymer PEI$_{10K}^{75Q}$ (11)

IR (ATR; ν [cm^{-1}]): 3238, 3015, 2944, 2826, 1641, 1478, 1348, 1292, 1098, 1055, 965, 918, 506. ^{1}H-NMR (D$_2$O, δ/ppm): 2.65 – 3.00 (br, D-C*H*$_2$-CH$_2$-D, D-C*H*$_2$-CH$_2$-L, D-C*H*$_2$-CH$_2$-T,

L-C*H*$_2$-CH$_2$-D, L-C*H*$_2$-CH$_2$-L, L-C*H*$_2$-CH$_2$-T, T-C*H*$_2$-CH$_2$-D, T-C*H*$_2$-CH$_2$-L), 3.34 (s, 9H, N(C*H*$_3$)$_3$), 3.45 – 3.60 (br, 4H, -C*H*$_2$-N(CH$_3$)$_3$), -RN-C*H*$_2$-CHOH-), 4.30 – 4.55 (br, 1H, CH$_2$-C*H*OH-CH$_2$-).

^{13}C-NMR (D$_2$O, δ/ppm): 45.9 (L-*C*H$_2$-CH$_2$-D), 51.7 (D-*C*H$_2$-CH$_2$-D), 54.3 (-N(*C*H$_3$)$_3$), 63.8 (L-*C*H$_2$-CHOH-), 64.3 (T-(*C*H$_2$-CHOH-CH$_2$-N(CH$_3$)$_3$)$_2$), 65.0 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 66.5 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 68.3 (T-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 69.2 (L-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 73.3 (D-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$). Elemental analysis: found (calc. for [C$_2$H$_4$N]$_{1-x}$[C$_8$H$_{19}$ClN$_2$O]$_x$, x=1.0): C: 45.01 (49.35); H: 10.37 (9.83); N: 13.71 (14.39).

Data S13. The IR, ^{1}H-NMR, ^{13}C-NMR and elemental analysis results of Quat-Primer polymer PEI$_{10K}^{100Q}$ (12)

IR (ATR; ν [cm^{-1}]): 3262, 2932, 2885, 2808, 1593, 1456, 1357, 1293, 1107, 1054, 915, 760. ^{1}H-NMR (D$_2$O, δ/ppm): 2.40 – 2.90 (br, D-C*H*$_2$-CH$_2$-D, D-C*H*$_2$-CH$_2$-L, D-C*H*$_2$-CH$_2$-T, L-C*H*$_2$-CH$_2$-D, L-C*H*$_2$-CH$_2$-L, L-C*H*$_2$-CH$_2$-T, T-C*H*$_2$-CH$_2$-D, T-C*H*$_2$-CH$_2$-L), 3.23 (s, 9H, N(C*H*$_3$)$_3$), 3.35 – 3.55 (br, 4H, -C*H*$_2$-N(CH$_3$)$_3$), -RN-C*H*$_2$-CHOH-), 4.20 – 4.50 (br, 1H, CH$_2$-C*H*OH-CH$_2$-). ^{13}C-NMR (D$_2$O, δ/ppm): 37.9 (NH$_2$-*C*H$_2$-CH$_2$-D), 40.0 (NH$_2$-*C*H$_2$-CH$_2$-L), 45.7 (L-*C*H$_2$-CH$_2$-D), 47.8 (L-*C*H$_2$-CH$_2$-L), 50.6 (L-*C*H$_2$-CH$_2$-NH$_2$), 51.2 (D-*C*H$_2$-CH$_2$-D), 53.2 (D-*C*H$_2$-CH$_2$-L), 54.3 (-N(*C*H$_3$)$_3$), 56.2 (D-CH$_2$CH$_2$-NH$_2$), 63.7 (L-*C*H$_2$-CHOH-), 64.2 (T-(*C*H$_2$-CHOH-CH$_2$-N(CH$_3$)$_3$)$_2$), 64.8 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 66.5 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 68.4 (T-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 69.3 (L-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 73.3 (D-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$). Elemental analysis: found (calc. for [C$_2$H$_4$N]$_{1-x}$[C$_8$H$_{19}$ClN$_2$O]$_x$, x=0.15): C: 52.04 (54.54); H: 11.55 (11.34); N: 27.51 (29.04).

Data S14. The IR, ^{1}H-NMR, ^{13}C-NMR and elemental analysis results of Quat-Primer polymer PEI$_{60K}^{5Q}$ (13)

IR (ATR; ν [cm^{-1}]): 3257, 2934, 2813, 1595, 1458, 1351, 1297, 1105, 1052, 966, 917, 760, 545. ^{1}H-NMR (D$_2$O, δ/ppm): 2.30 – 2.90 (br, D-C*H*$_2$-CH$_2$-D, D-C*H*$_2$-CH$_2$-L, D-C*H*$_2$-CH$_2$-T,

L-C*H*$_2$-CH$_2$-D, L-C*H*$_2$-CH$_2$-L, L-C*H*$_2$-CH$_2$-T, T-C*H*$_2$-CH$_2$-D, T-C*H*$_2$-CH$_2$-L), 3.25 (s, 9H, N(C*H*$_3$)$_3$), 3.35 – 3.55 (br, 4H, -C*H*$_2$-N(CH$_3$)$_3$), -RN-C*H*$_2$-CHOH-), 4.25 – 4.50 (br, 1H, CH$_2$-C*H*OH-CH$_2$-). ^{13}C-NMR (D$_2$O, δ/ppm): 37.9 (NH$_2$-*C*H$_2$-CH$_2$-D), 39.9 (NH$_2$-*C*H$_2$-CH$_2$-L), 45.7 (L-*C*H$_2$-CH$_2$-D), 47.8 (L-*C*H$_2$-CH$_2$-L), 50.7 (L-*C*H$_2$-CH$_2$-NH$_2$), 51.2 (D-*C*H$_2$-CH$_2$-D), 53.2 (D-*C*H$_2$-CH$_2$-L), 54.3 (-N(*C*H$_3$)$_3$), 56.0 (D-CH$_2$CH$_2$-NH$_2$), 63.7 (L-*C*H$_2$-CHOH-), 64.1 (T-(*C*H$_2$-CHOH-CH$_2$-N(CH$_3$)$_3$)$_2$), 65.1 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 66.5 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 68.3 (T-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 69.1 (L-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 73.3 (D-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$). Elemental analysis: found (calc. for $[C_2H_4N]_{1-x}[C_8H_{19}ClN_2O]_x$, x=0.15): C: 48.68 (52.92); H: 11.06 (10.87); N: 22.39 (24.47).

Data S15. The IR, ^{1}H-NMR, ^{13}C-NMR and elemental analysis results of Quat-Primer polymer PEI$_{60K}^{15Q}$ (14)

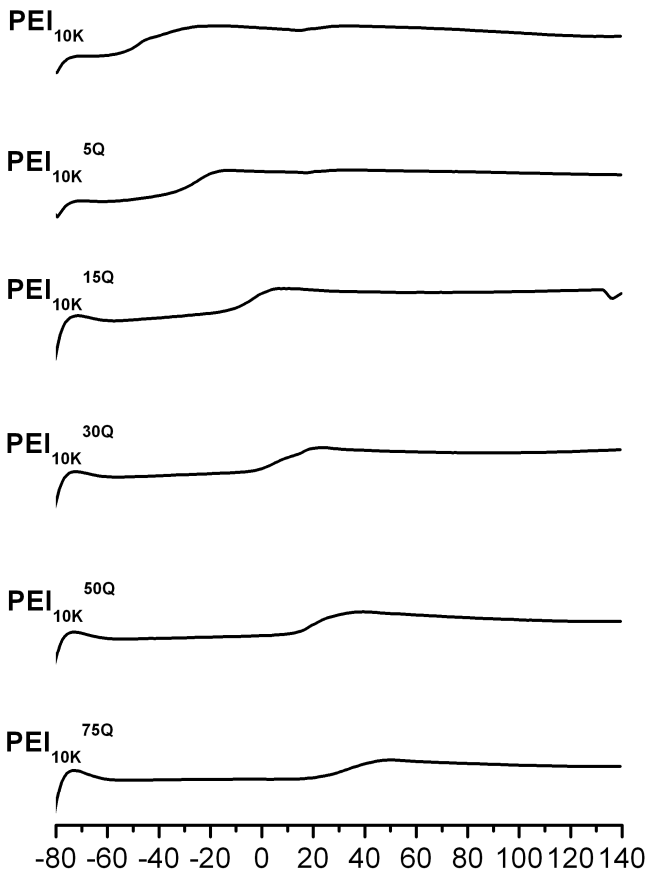
IR (ATR; ν [cm^{-1}]): 3652, 3250, 2980, 2819, 1594, 1475, 1381, 1265, 1125, 1059, 965, 918, 759, 522. ^{1}H-NMR (D$_2$O, δ/ppm): 2.50 – 2.90 (br, D-C*H*$_2$-CH$_2$-D, D-C*H*$_2$-CH$_2$-L, D-C*H*$_2$-CH$_2$-T, L-C*H*$_2$-CH$_2$-D, L-C*H*$_2$-CH$_2$-L, L-C*H*$_2$-CH$_2$-T, T-C*H*$_2$-CH$_2$-D, T-C*H*$_2$-CH$_2$-L), 3.24 (s, 9H, N(C*H*$_3$)$_3$), 3.35 – 3.55 (br, 4H, -C*H*$_2$-N(CH$_3$)$_3$), -RN-C*H*$_2$-CHOH-), 4.20 – 4.50 (br, 1H, CH$_2$-C*H*OH-CH$_2$-). ^{13}C-NMR (D$_2$O, δ/ppm): 38.0 (NH$_2$-*C*H$_2$-CH$_2$-D), 39.9 (NH$_2$-*C*H$_2$-CH$_2$-L), 45.7 (L-*C*H$_2$-CH$_2$-D), 47.8 (L-*C*H$_2$-CH$_2$-L), 50.5 (L-*C*H$_2$-CH$_2$-NH$_2$), 51.2 (D-*C*H$_2$-CH$_2$-D), 53.2 (D-*C*H$_2$-CH$_2$-L), 54.3 (-N(*C*H$_3$)$_3$), 55.8 (D-CH$_2$CH$_2$-NH$_2$), 63.7 (L-*C*H$_2$-CHOH-), 64.2 (T-(*C*H$_2$-CHOH-CH$_2$-N(CH$_3$)$_3$)$_2$), 64.8 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 66.5 (-*C*HOH-CH$_2$-N(CH$_3$)$_3$), 68.4 (T-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 69.3 (L-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$), 74.6 (D-CH$_2$-CHOH-*C*H$_2$-N(CH$_3$)$_3$). Elemental analysis: found (calc. for $[C_2H_4N]_{1-x}[C_8H_{19}ClN_2O]_x$, x=0.3): C: 44.08 (51.54); H: 10.78 (10.47); N: 17.16 (20.56).

Data S16. The IR, ^{1}H-NMR, ^{13}C-NMR and elemental analysis results of Quat-Primer polymer PEI$_{60K}^{30Q}$ (15)

Table S1: Composition of the prepared Quat-Primer polymers 1 - 15

	Reaction conditions		**Results**	
entry	**PEI** M_n **(g mol^{-1})**	**equivalent GTMACl**[a]	**degree of quarternization**	
			^{1}H NMR (%)	**elemental analysis (%)**
01	423	0.05	05.5	03.7
02	423	0.15	17.0	15.2
03	423	0.30	30.9	31.3
04	1200	0.05	04.8	02.7
05	1200	0.15	14.7	14.9
06	1200	0.30	28.3	29.3
07	10000	0.05	05.5	06.4
08	10000	0.15	14.7	15.7
09	10000	0.30	29.4	34.6
10	10000	0.50	48.8	49.4
11	10000	0.75	68.0	74.4
12	10000	1.00	79.7	84.3
13	60000	0.05	04.8	05.5
14	60000	0.15	15.0	15.5
15	60000	0.30	30.7	33.2

a: Reaction time 24 hours. Temperature: 25°C. Solvent: H_2O.



Data S17: Differential scanning calorimetry of polyethyleneimine PEI_{10k} and Quat-Primer polymers PEI_{10K}^{xQ} with Q= 5; 15; 30; 50 and 75 (dT/dt = 10 K/min).

Table S2 : Solubility of quat-primer polymers in different solvents; C = 10mg/mL; T = room temperature (s = soluble; sw = swelling; u = unsoluble)

Solvent	**Polymer PEI_{nK}^{xQ}**										
	$PEI_{0.423K}^{15Q}$	**$PEI_{0.423K}^{30Q}$**	**$PEI_{1.2K}^{15Q}$**	**$PEI_{1.2K}^{30Q}$**	**PEI_{10K}^{15Q}**	**PEI_{10K}^{30Q}**	**PEI_{10K}^{50Q}**	**PEI_{10K}^{75Q}**	**PEI_{10K}^{100Q}**	**PEI_{60K}^{15Q}**	**PEI_{60K}^{30Q}**
Water	s	s	s	s	s	s	s	s	s	s	s
Methanol	s	s	s	s	s	s	s	s	s	s	s
Ethanol	s	s	s	s	s	s	s	s	s	s	s
2-Propanol	s	s	s	s	s	s	s	s	s	s	s
DMF	s	s/sw	sw	sw	sw	sw	u	u	u	u	u
THF	sw	sw	sw	u	sw	u	u	u	u	u	u
Acetone	sw/u	u	u	u	u	u	u	u	u	u	u
Ethyl acetate	u	u	u	u	u	u	u	u	u	u	u
Toluene	u	u	u	u	u	u	u	u	u	u	u
n-Hexane	u	u	u	u	u	u	u	u	u	u	u

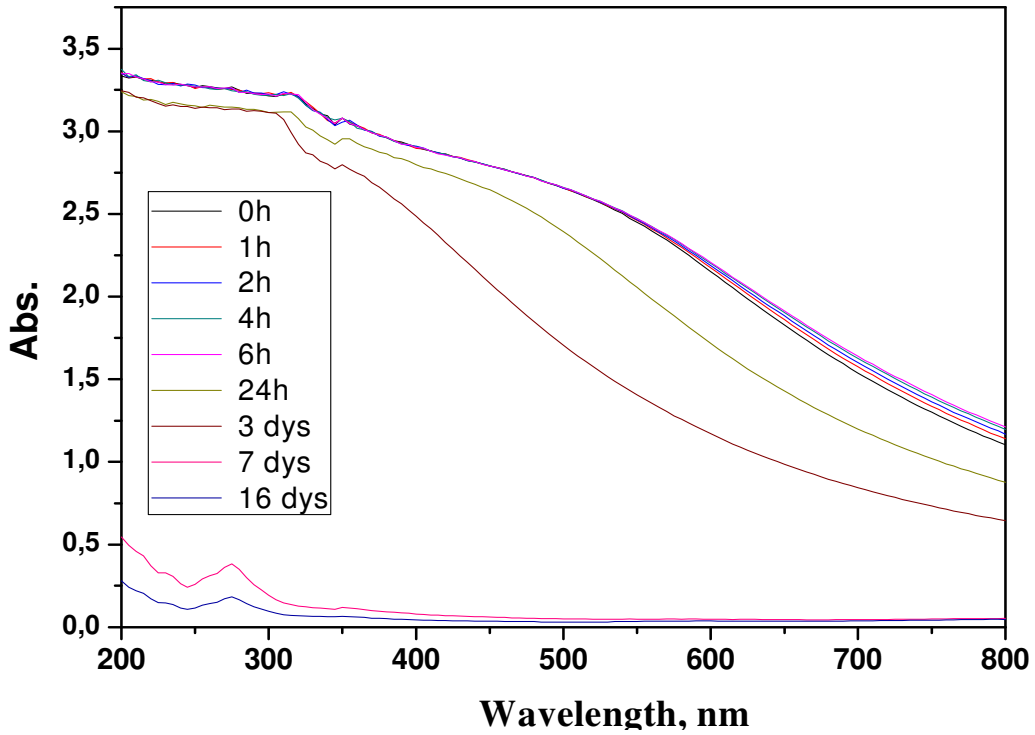
Table S3: Dispersion experiments of different Quat-Primer polymers PEI_{nK}^{xQ} in several buffer solutions; the dispersion stability was observed for 15 – 30 minutes.

	Buffer 1, pH - 4	**Buffer 2, pH - 7**	**Buffer 3, pH - 9**	**Buffer 4, pH - 11**
PEI_{10K}^{5Q}	P	D	D (slowly P)	P
PEI_{10K}^{15Q}	P (but slowly)	D	D (slowly P)	P
PEI_{10K}^{30Q}	D	D	D (slowly P)	P
PEI_{10K}^{50Q}	D	D	P (but slowly)	P
PEI_{60K}^{5Q}	P	P (partially D)	D	P
PEI_{60K}^{30Q}	D (slowly P)	D	D (slowly P)	P

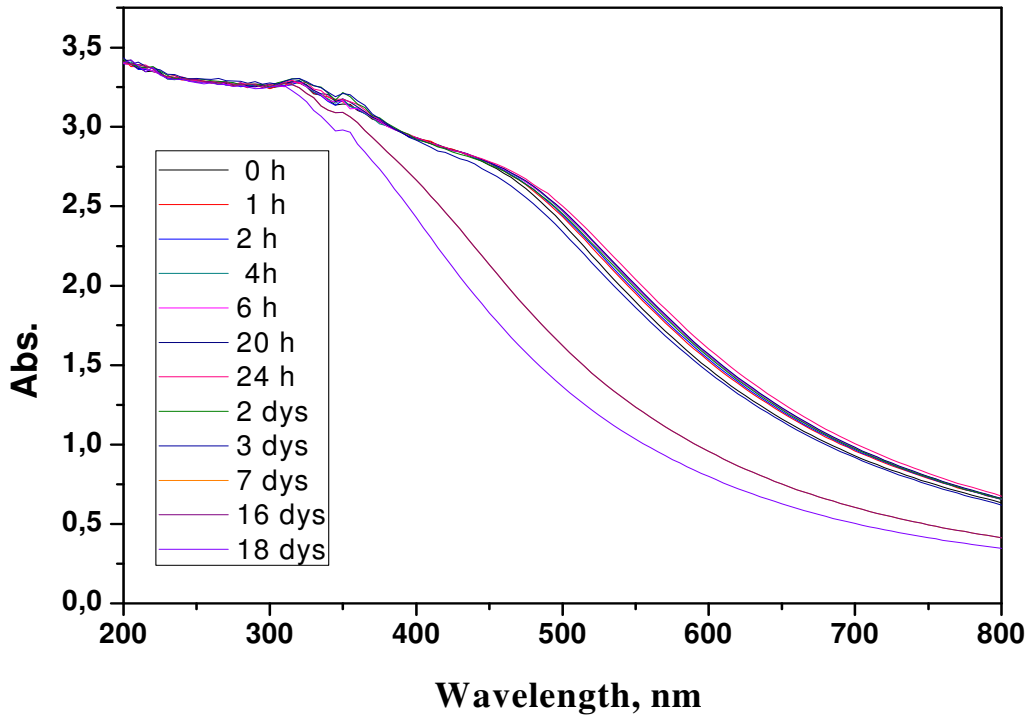
D = Dispersible , P = Precipitating

Table S4: Results of dispersion screening experiments with 1.0 wt% of NRs in the presence of PEI Quat-Primer polymers PEI_{nK}^{xQ} one day after preparation

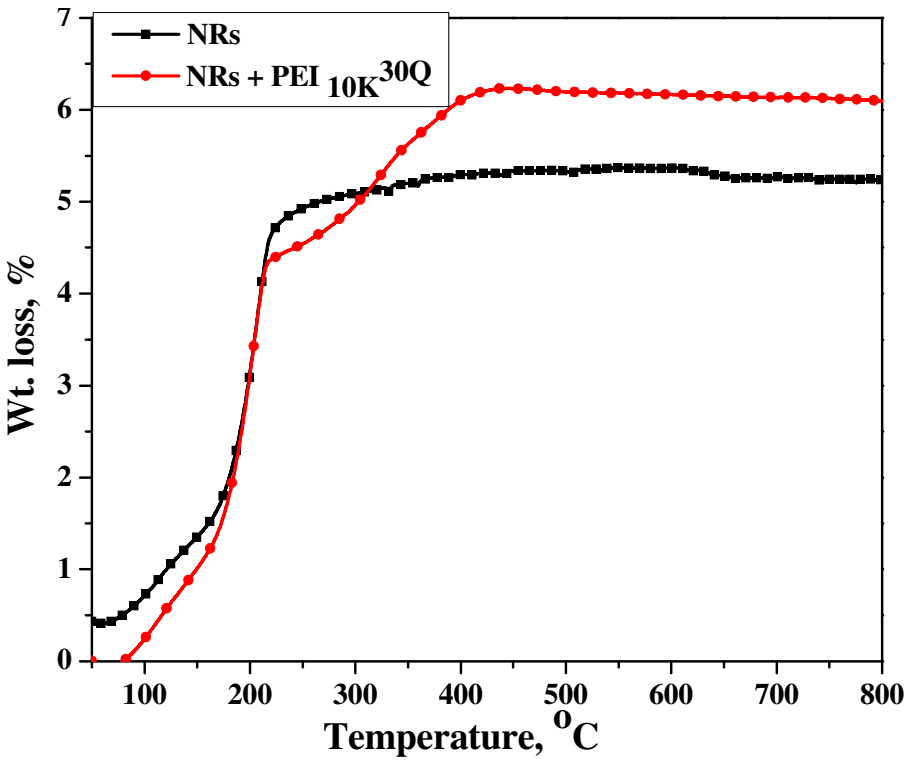
Quat-Polymers	**1.000 wt. %**	**0.750 wt. %**	**0.500 wt. %**	**0.250 wt. %**	**0.100 wt. %**	**0.010 wt. %**	**0.001 wt. %**
$\mathbf{PEI_{0.423K}^{15Q}}$	-	-	-	-	-	D	-
$\mathbf{PEI_{0.423K}^{30Q}}$	-	-	-	-	-	D	-
$\mathbf{PEI_{10K}^{15Q}}$	D (slow P)	D (slow P)	D (slow P)	D (slow P)	D (slow P)	D	D
$\mathbf{PEI_{10K}^{30Q}}$	P	P	D	D	D	D	D (slow P)
$\mathbf{PEI_{10K}^{50Q}}$	D (slow P)	D (slow P)	D (slow P)	D (slow P)	D (slow P)	-	-
$\mathbf{PEI_{10K}^{75Q}}$	P	P	P	P	D (slow P)	-	-
$\mathbf{PEI_{10K}^{100Q}}$	P	P	P	P	D	D	D (slow P)
$\mathbf{PEI_{60K}^{15Q}}$	-	-	-	-	-	D	-
$\mathbf{PEI_{60K}^{30Q}}$	-	-	-	-	-	D (slow P)	-



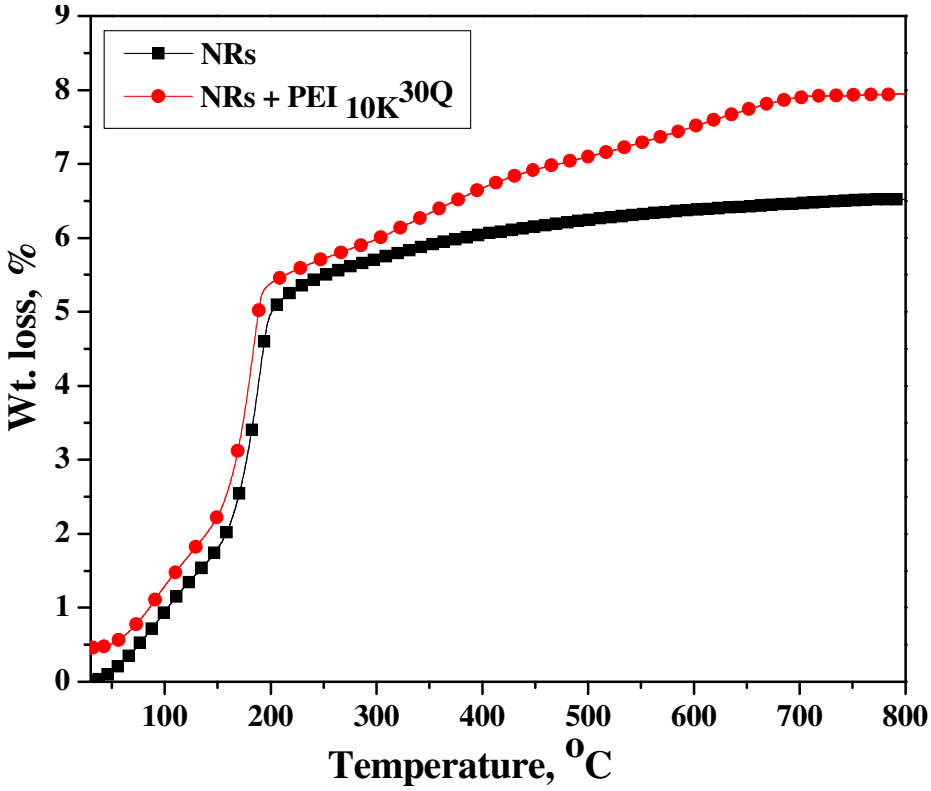
Data S18: UV-Visible spectra of bare NRs measured at different intervals



Data S19: UV-Visible spectra of modified NRs (NRs+ PEI_{10K}^{30Q}) measured at different intervals



Data S20: TGA analysis in air (where black squares correspond to bare NRs and the red circle is modified NRs).



Data S21: TGA analysis in helium (where black squares correspond to bare NRs and the red circle is modified NRs).