SUPPORTING INFORMATION

Preparation of Conducting Polymer-coated TEMs

Tables S1 and S2 detail the amounts of monomer and oxidant used for each targeted conducting polymer loading on the TEMs. Conducting polymer overlayer thicknesses were calculated using the equation:

$$x = R\left\{\left[\left(\frac{M_2\rho_1}{M_1\rho_2}\right)+1\right]^{\frac{1}{3}}-1\right\}$$

where x is the mean thickness of the conducting polymer overlayer, R is the mean radius of uncoated TEMs, M_1 and M_2 are the mass fractions of the uncoated TEMs and the conducting polymer respectively, and ρ_1 and ρ_2 are the densities of the uncoated TEMs and the conducting polymer, respectively. [S. F. Lascelles, S. P. Armes, *Journal of Materials Chemistry*, **1997,** *7*, 1339.] For the uncoated TEMs, ρ_1 was taken to be 1.22 g cm^{-3}. [A. Schmid, L. R. Sutton, S. P. Armes, P. S. Bain and G. Manfrè, *Soft Matter,* **2009,** *5,* 407.] For both polypyrrole and polyaniline, ρ_2 was taken to be 1.45 g cm^{-3}, while for PEDOT, ρ_2 was taken to be 1.60 g cm^{-3}.

PPy loading (wt. %)	**TEMs (g)**	**PPy (g)**	**Pyrrole (µL)**	**$FeCl_3$ (g)**	**PPy shell thickness (nm)**
1.5	12.5	0.1875	169.2	1.54	28
1.0	12.5	0.125	112.8	1.03	18
0.5	12.5	0.0625	56.4	0.51	9
0.4	12.5	0.050	45.1	0.41	7
0.3	12.5	0.0375	33.8	0.31	6
0.2	12.5	0.025	22.6	0.21	4
0.1	12.5	0.0125	11.3	0.10	2

Table S1. Summary of the quantities of TEMs, pyrrole monomer and $FeCl_3$ oxidant used in the synthesis of each targeted PPy loading, alongside the calculated PPy shell thicknesses.

PANi loading (wt. %)	TEMs (g)	PANi (g)	Aniline hydrochloride (g)	APS(g)	PANi shell thickness (nm)
1.5	12.5	0.1875	0.223	0.491	28
1.0	12.5	0.125	0.149	0.328	18
0.5	12.5	0.0625	0.074	0.164	9
0.3	12.5	0.0375	0.045	0.098	6

Table S2. Summary of the quantities of TEMs, aniline hydrocloride and ammonium persulfate (APS) oxidant used in the synthesis of each targeted PANi loading, alongside the calculated PANi shell thicknesses.

Infra-red Lamp Irradiation Experiments

The IR lamp set-up was designed to provide relatively uniform irradiation of the TEMs inside the test tube (see Figure S1 in Supporting Information). The experimental set-up consisted of a base and vertical surround, which were both wrapped with aluminium foil to enable efficient reflection of infra-red radiation onto the test tube, and an infra-red lamp (Trisk UK ETS221d; 3.3 kW; maximum absorption wavelength, λ_{max}, occurs at approximately 1200 nm) placed at a distance of 10 cm from the test tube. This optimal distance was determined empirically after initial experiments conducted at closer distances led to substantial sample charring, which prevented accurate estimation of the total expansion time required for volumetric expansion of the TEMs. In each experiment, a single test tube containing dried TEMs (0.70 g) was placed within the middle of the base in a fixed position relative to the IR lamp. In situ expansion of the TEM particles led to an easily visualised increase in sample volume. The onset and total expansion times were recorded with a stopwatch, and the experiment was repeated at least three times for each sample in order to ensure reliability and reproducibility.

Figure S1. Schematic representation of the experimental setup used for the infra-red lamp irradiation studies.