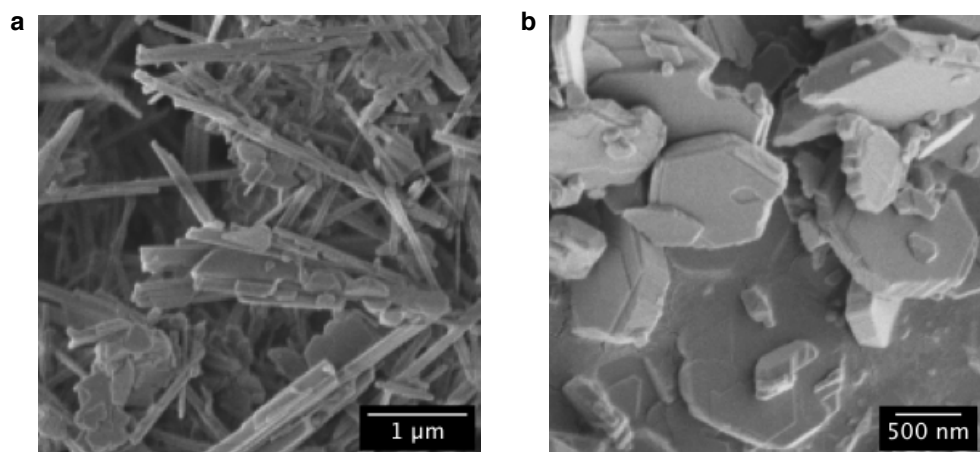
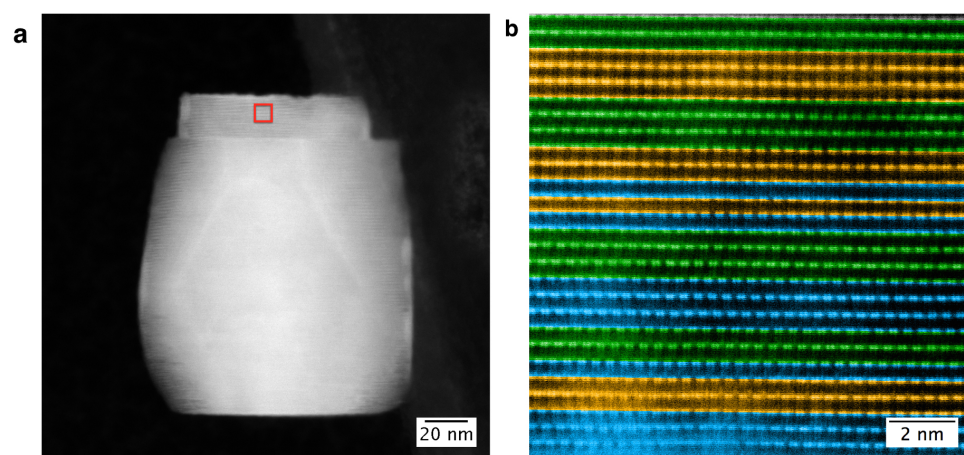


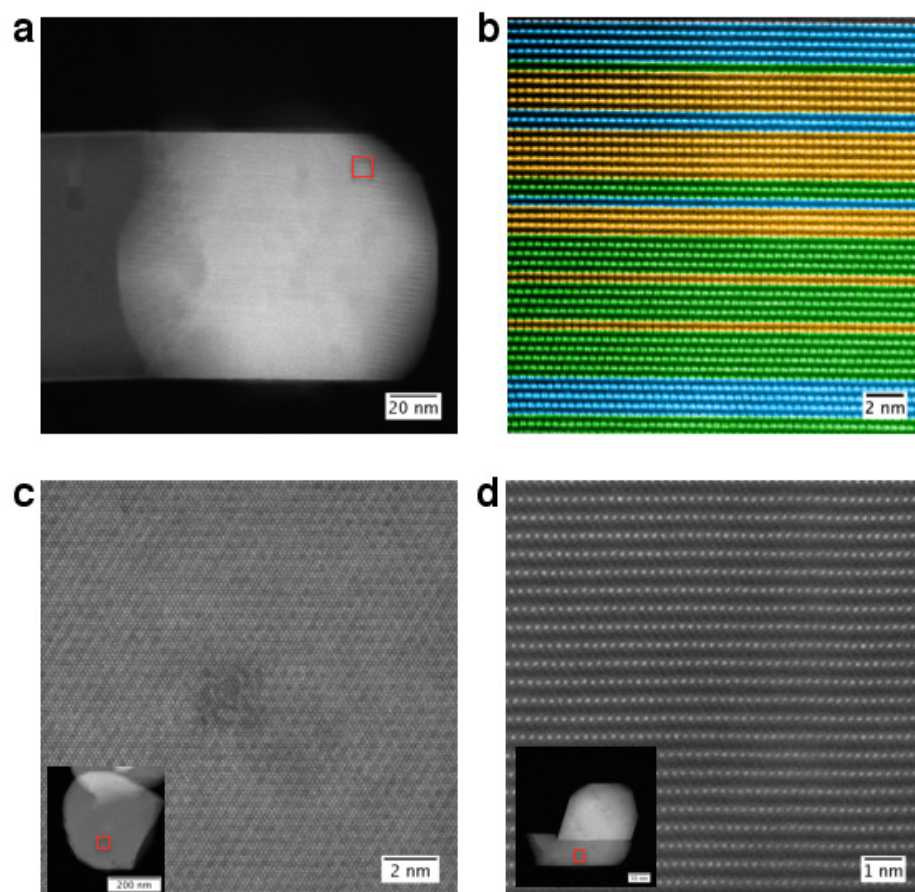
## Supplementary Figures



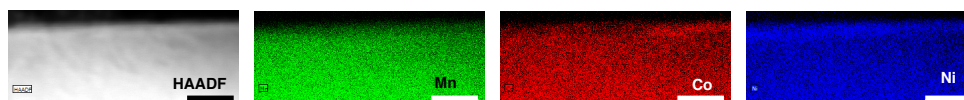
Supplementary Figure 1: SEM images for **a**, needles and **b**, plates showing the morphology of LRTMO primary particles.



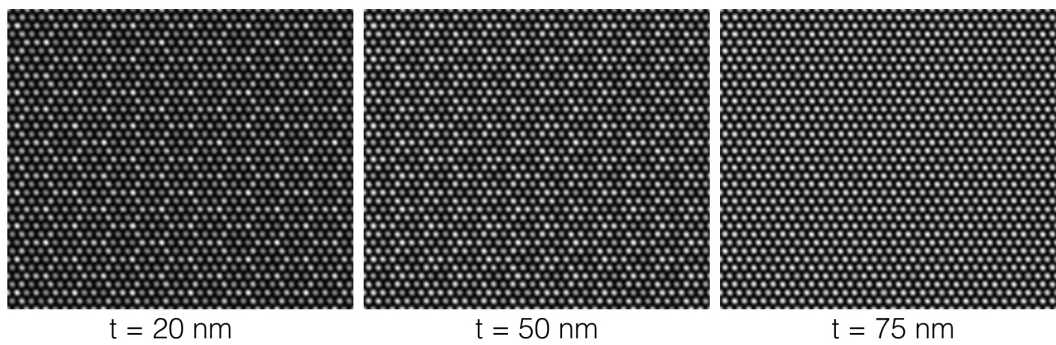
Supplementary Figure 2: HAADF STEM images showing the structure in commercial material HCMR<sup>TM</sup>XLE2 **a**, Low magnification image showing a primary particle **b**, Higher magnification image using from the particle in **a** showing the domains representing monoclinic structure in  $[1\ 1\ 0]$ ,  $[1\ \bar{1}\ 0]$  and  $[1\ 1\ 0]$  directions.



Supplementary Figure 3: HAADF STEM images showing the structure in commercial material Toda HE5050 **a**, Low magnification image taken using  $[100]_{\text{supercell}}$  zone axis. **b**, image showing the domains representing monoclinic structure in  $[110]$ ,  $[1\bar{1}0]$  and  $[110]$  directions, **c**, image showing the criss-cross pattern representing three variants of monoclinic phase in  $[103]$  direction. **d**, image taken using  $[010]_{\text{monoclinic}}$  zone axis.



Supplementary Figure 4: XEDS maps taken on HCMR<sup>TM</sup> XLE2 sample showing Ni segregation on the surface. The scale bar is 20 nm.



Supplementary Figure 5: STEM Simulation of spinel using different thicknesses.

## Supplementary Table

Supplementary Table 1: Equivalent directions

<b>Monoclinic</b>	<b>Supercell</b>
$[1\ 0\ 0]$ , $[1\ 1\ 0]$ and $[1\ \bar{1}\ 0]$	$[1\ 0\ 0]$
$[0\ 1\ 0]$	$[0\ 1\ 0]$
$[1\ 0\ 3]$	$[0\ 0\ 1]$