

Supplementary Information

Simple, rapid and efficient flame synthesis of ultrafine $\text{LiNi}_{0.95-x}\text{Co}_x\text{Ti}_{0.05}\text{O}_2$ ($x = 0.25$ and 0.30): a versatile route to synthesize the Ni-rich cathode materials for Li-ion batteries

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Supplementary Information S1: The current automatic flame synthetic method can be a viable alternative for the fabrication of commercialized analogous structured cathode material such as $\text{LiNi}_{0.8}\text{Co}_{0.2}\text{O}_2$, $\text{LiNi}_{0.76}\text{Co}_{0.24}\text{O}_2$, and $\text{LiNi}_{0.8}\text{Co}_{0.15}\text{Al}_{0.05}\text{O}_2$ for Li-ion batteries. Herein, for the plausibility of this procedure, we have synthesized the complex system of $\text{LiNi}_{0.7}\text{Co}_{0.3}\text{O}_2$. The synthesis of $\text{LiNi}_{0.7}\text{Co}_{0.3}\text{O}_2$ and other commercial complex cathode and $\text{LiNi}_{0.8}\text{Co}_{0.15}\text{Al}_{0.05}\text{O}_2$ is tangled due to additional nickel ions on the lithium sites, and deviate from its normal stoichiometry¹. Ni-rich isostructural compounds of $\text{LiNi}_{1-y}\text{Co}_y\text{O}_2$, are the most potential cathode materials due to high specific capacity and low cost. The conventional methods for the fabrication of $\text{LiNi}_{1-y}\text{Co}_y\text{O}_2$ systems are solid-state technique, molten salt synthesis, hydrothermal technique, and precipitation technique, self-combustion synthesis and sol-gel technique. However, the traditional solid-state route requires high temperature and long duration and may give the compositionally inhomogeneous products and incomplete reaction. Moreover, the wet chemistry methods such as precipitation, self-combustion synthesis and sol-gel to synthesize $\text{LiNi}_{1-y}\text{Co}_y\text{O}_2$ are complex in nature with multi-step processes such as needs to

prepare aqueous solutions of the desired Li, Ni, and Co acetate/nitrate, maintain oxidant fuel ratios, and pre-calcination steps to remove the unreacted or residue organic species which increase the energy consumption along with long duration of 36 – 48 hrs²⁻⁵. Therefore, we urgently require a revolutionary simplest wet chemistry chemical route for realistic application which far better than the traditional precipitation, self-combustion synthesis and sol-gel. The present flame synthesis technique is simple and rapid (30-55 min) for the $\text{LiNi}_{0.95-x}\text{Co}_x\text{Ti}_{0.05}\text{O}_2$ ($x = 0.25$ and 0.30). It will be also very attractive for the facile fabrication of structurally similar lithiated nickel–cobalt oxides for mass production. The entire procedure of this automatic flame synthetic method to obtain the precursor powder of $\text{LiNi}_{0.7}\text{Co}_{0.3}\text{O}_2$ took only 30 - 50 min. An XRD pattern of the flame synthesized $\text{LiNi}_{0.7}\text{Co}_{0.3}\text{O}_2$ precursor powder and calcined at 800 °C for 12 hrs is shown in Figure S1. The XRD pattern of precursor powder just collected after completion of flame reaction show the good crystallinity with the mixed phase of $\text{LiNi}_{0.7}\text{Co}_{0.3}\text{O}_2$, LiCoO_2 and CoO . The XRD pattern of $\text{LiNi}_{0.7}\text{Co}_{0.3}\text{O}_2$ calcined at 800 °C for 12 hrs is isostructural with LiNiO_2 and LiCoO_2 phases without any minor phases and impurity peaks. XRD pattern also shows the sharp peaks indicating a high degree of crystallinity with highly layered structure. Therefore, the present synthesis method will open a new economic synthetic method for the commercially available Ni-rich $\text{LiNi}_{0.8}\text{Co}_{0.2}\text{O}_2$, $\text{LiNi}_{0.76}\text{Co}_{0.24}\text{O}_2$, and $\text{LiNi}_{0.8}\text{Co}_{0.15}\text{Al}_{0.05}\text{O}_2$ systems as cathode material for Li-ions batteries.

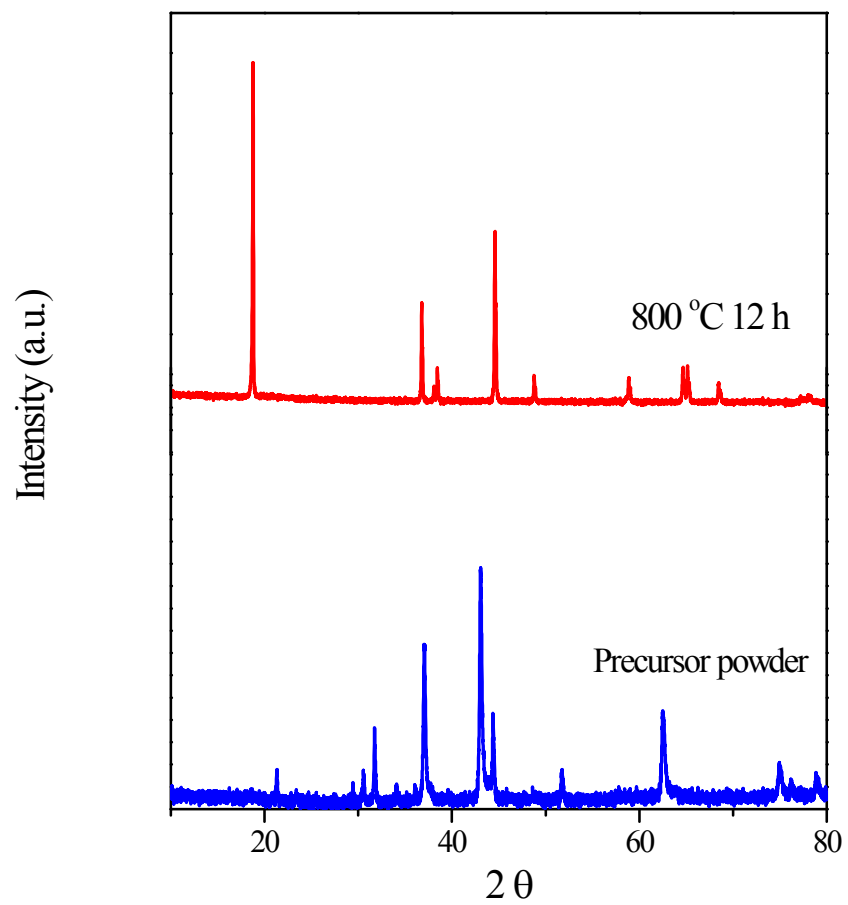


Fig. S1 XRD patterns of flame synthesized $\text{LiNi}_{0.7}\text{Co}_{0.3}\text{O}_2$ (a) precursor powder and (b) calcined 800 °C for 12 hrs.

Supplementary Information S2: A video has been recorded during the flame synthetic procedure.

Supplementary Information for Figure S3:

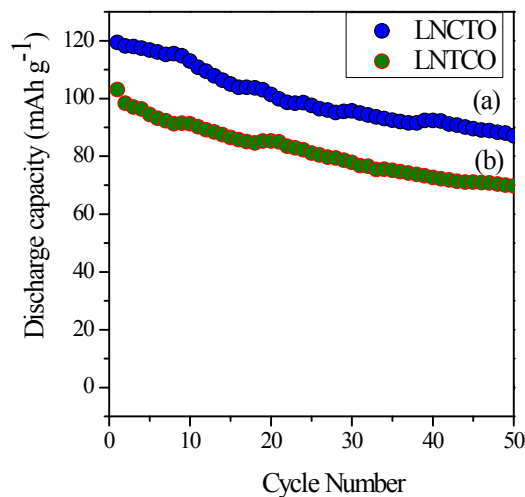


Fig. S3 Cycling performances of the flame synthesized (a) LNCTO and (b) LNTCO at 1 C rate.

References

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