

# High Energy Density In-situ Sodium Plated battery with Current Collector Foil as Anode

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We report the viability of an *in-situ* sodium plated battery (INPB) using a non-flammable electrolyte which could become an inexpensive, safer and high energy density battery technology for the future. Our INPB consists of an anode being simply a Cu current collector foil without any modification or surface coating and with the cell being assembled in the discharged state with a Na containing cathode, without any pre-sodiation or pre-cycling steps. The reported INPB battery system viz. R-Na<sub>2</sub>Fe<sub>2</sub>(CN)<sub>6</sub>//Cu was cycled successfully with repeated Na plating and stripping on the current collector, during each charge and discharge cycle, respectively, with the cathode functioning in the similar way, as it would be in a sodium-ion battery (NIB). INPB could deliver a specific energy density of 336 Wh/kg, much higher than any NIB full cell reported thus far without any pre-sodiation steps and competitive with existing commercial LIB full cells. Most notably, the cycling of such INPB was quite stable, displaying capacity retention of 76 % of its initial values in 100 cycles with high stable coulombic efficiency around 99-100 % after a few cycles. Such a highly efficient, stable and non-dendritic Na plating-stripping process on Cu current collector was made possible due to an optimized combination of a simple glyme-based non-flammable liquid electrolyte (1M NaBF<sub>4</sub> in tetraglyme)<sup>1</sup> and a specially designed cycling protocol<sup>2</sup>. With these preliminary results, we believe that the our non-flammable INPBs could be a one-stop inexpensive battery solution for the future low cost high energy density battery technology based on Earth-abundant material resources.

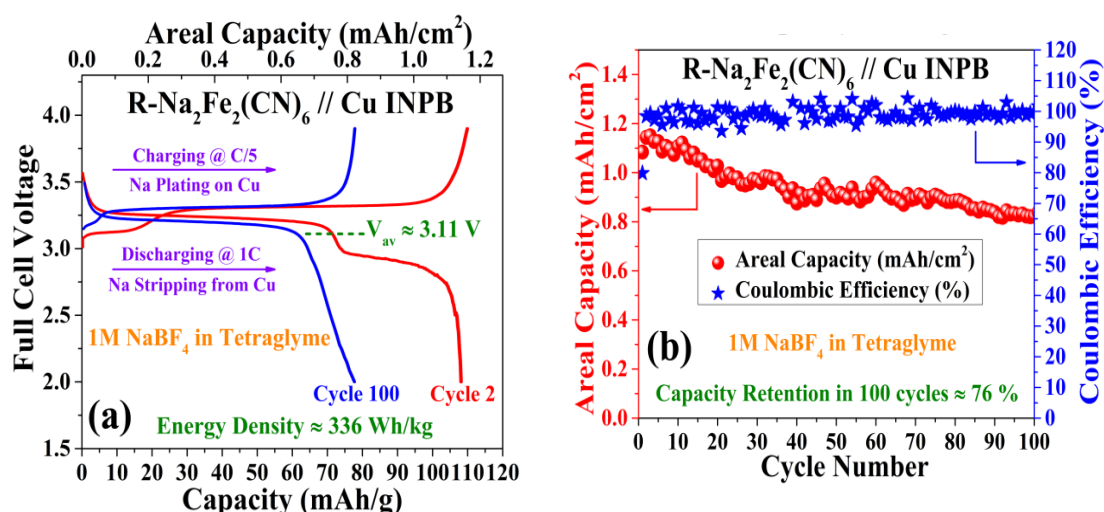


Figure (a) Cycling profiles of the 2<sup>nd</sup> and the 100<sup>th</sup> cycles. The specific capacity on the x-axis is based on the cathode AM wt. (b) Areal capacity and coulombic efficiency over long term cycling of INPB.

## References:

- [1] A. Rudola, K. Du, P. Balaya, J. Electrochem. Soc., 164,6, (2017), A1098-A1109
- [2] A. Rudola, S.R. Gajjela and P. Balaya, Electrochem. Commun., 86 (2018) 157–160