TUNABLE CARBON COATING OF $NaTi_2(PO_4)_3$ FOR IMPROVED BATTERY PERFORMANCE

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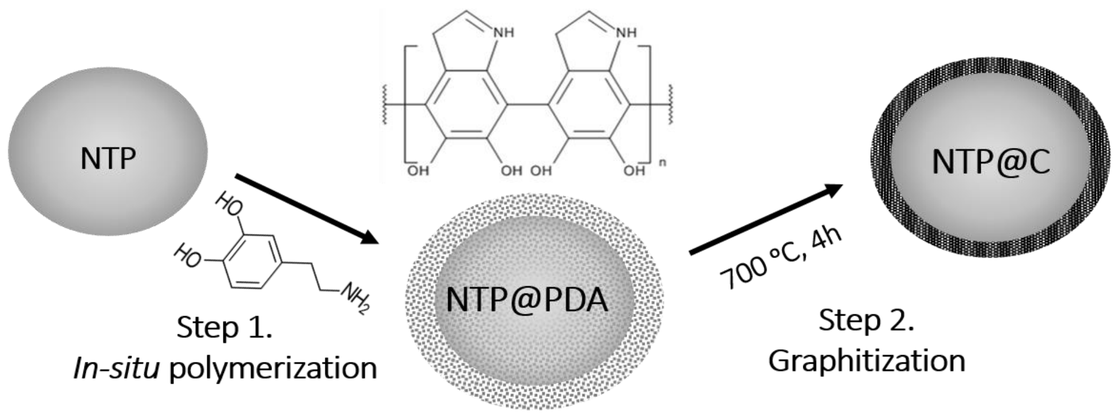
INTRODUCTION

NASICON-type $NaTi_2(PO_4)_3$ (NTP) is the most thoroughly investigated aqueous Na-ion battery negative electrode material due to its high theoretical capacity, remarkable thermal stability and environmental benignity. Despite being highly ionically conductive, the material suffers from inherently low electron conductivity [1]. Additionally, poor cycling stability is observed owing to the dissolution of inorganic active material into water-based electrolyte [2]. Traditional particle coating by graphitization of glucose or citric acid (CA) does not guarantee an even conductive carbon layer. Growing a precisely-controlled polymer e.g. polydopamine (PDA) shell on the particles prior to the pyrolization is a sensible way to both enhance stability and conductivity of active material [3].

EXPERIMENTAL

The composite was obtained through the continuous oxidation and self-polymerization of dopamine resulting in thin film of PDA adhered to the surface. The formation of NTP@C is schematically shown in Scheme 1.



Scheme 1. Schematic illustration of the synthesis of NTP@C composites.

RESULTS

The carbon content of the final product was determined by thermogravimetric analysis. The electrochemical properties of prepared $NaTi_2(PO_4)_3$ based electrodes are investigated by Cyclic voltammetry and Charge/Discharge galvanostatic cycling in the three-electrode bottom mount flat sample beaker cells. The results were compared to the electrodes prepared by conventional citric acid (CA) coating.

PDA, %	Carbon content, %	Capacity retention, %
+10% of NTP mass	2,7	92,0
+30% of NTP mass	4,3	91,9
+60% of NTP mass	4,8	94,9
+100% of NTP mass	4,8	94,5

Fig. 1. Thermogravimetrically measured carbon content and capacity retention after 100 cycles at 1 C rate for samples with PDA as a carbon precursor.

CA, %	Carbon content, %	Capacity retention, %
+20% of NTP mass	3,5	72,6
+40% of NTP mass	7,8	86,8
+60% of NTP mass	11,9	56,3

Fig. 2. Thermogravimetrically measured carbon content and capacity retention after 100 cycles at 1 C rate for samples with CA as a carbon precursor.

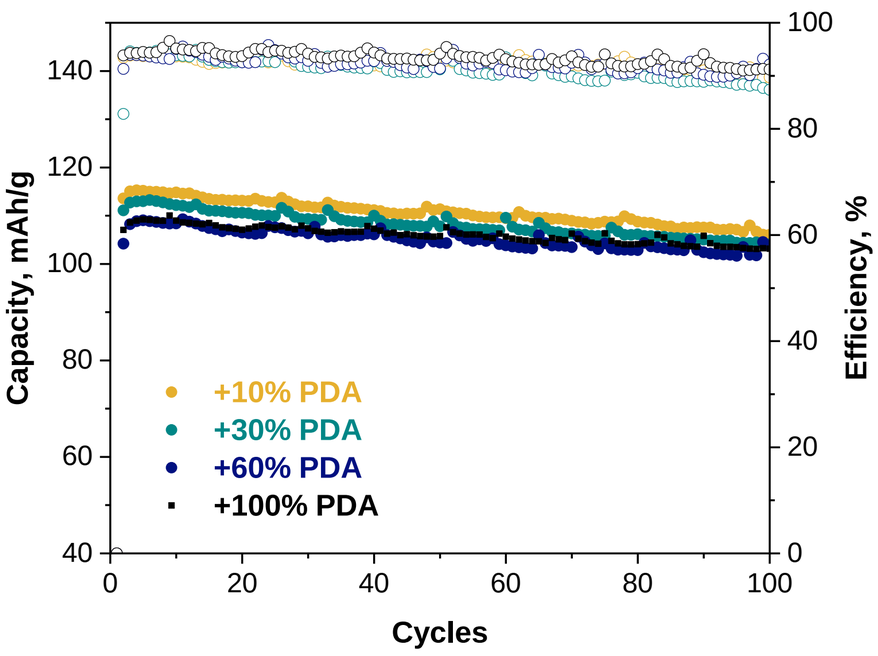


Fig. 3. Discharge capacities and charge/discharge efficiencies of electrodes prepared with PDA as a carbon precursor.

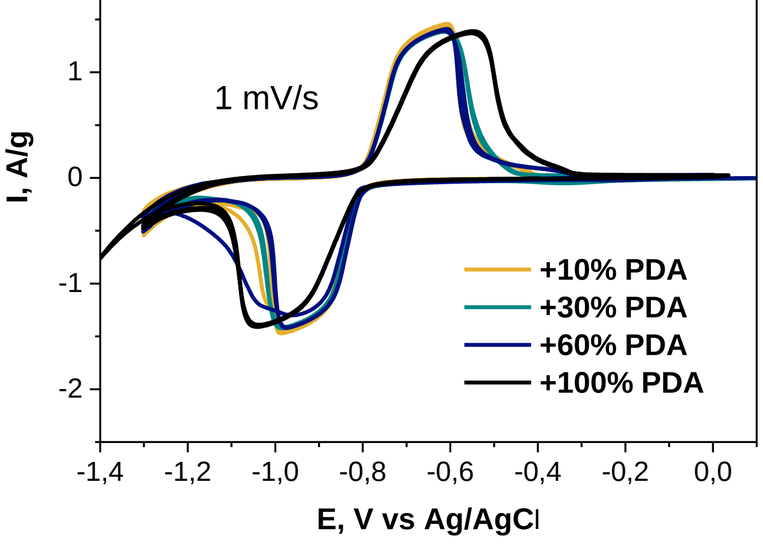


Fig. 5. Cyclic voltammograms of electrodes prepared with PDA as a carbon precursor.

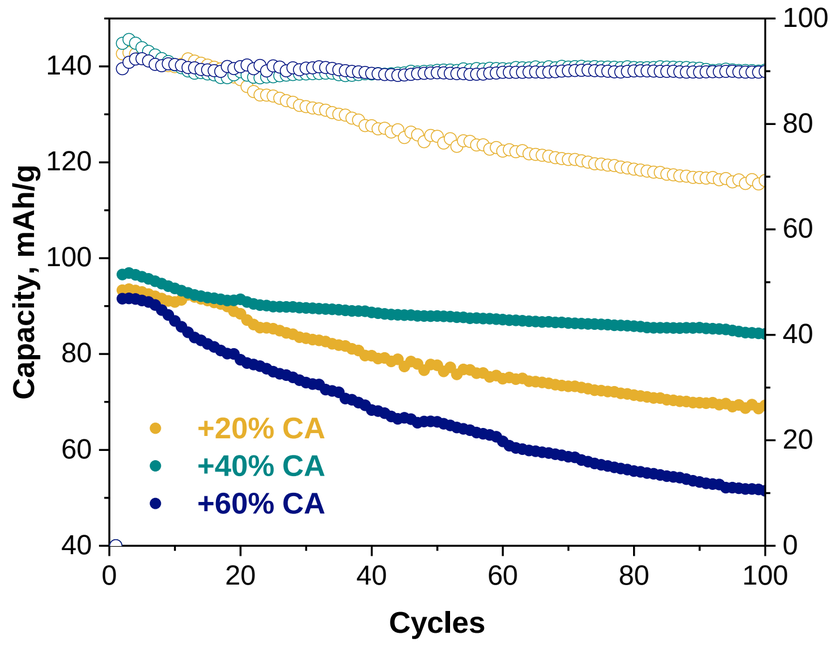


Fig. 4. Discharge capacities and charge/discharge efficiencies of electrodes prepared with CA as a carbon precursor.

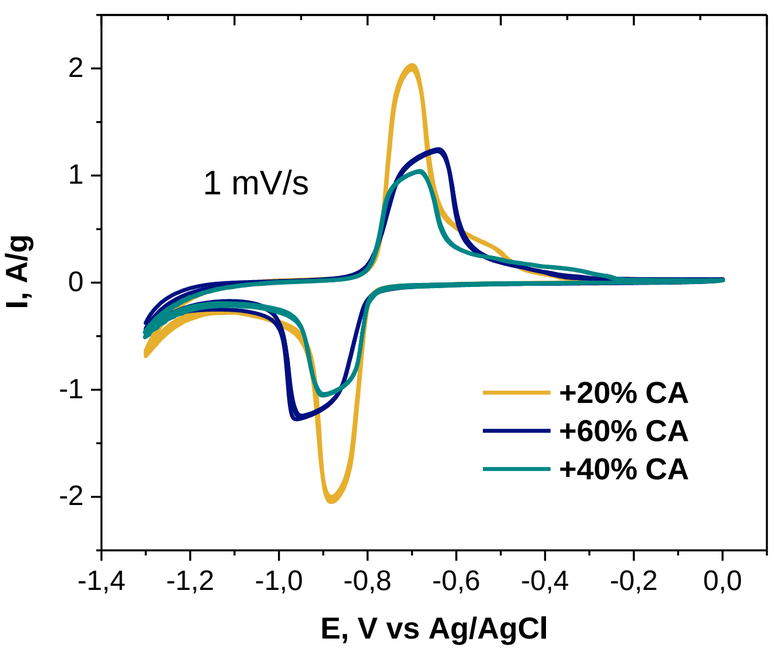


Fig. 6. Cyclic voltammograms of electrodes prepared with CA as a carbon precursor.

CONCLUSIONS

- All PDA coated samples exhibit enhanced capacity stability upon cycling compared to conventional citric acid coated
- Smaller content of carbon in final composites is required to sufficiently protect active materials when PDA is used as a carbon precursor
- Broadened CV peaks indicate efficient and even carbon distribution on the surface of the active material for PDA coated samples

REFERENCES

[1] Xu et al. *Nano energy* **28** p. 224-231 (2016)
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[3] Chi et al. *RSC Advances* **4** p. 7795-7798 (2014)