One-step C and N co-doped on $Li_4Ti_5O_{12}$ electrode by atmospheric pressure plasma treatment

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Lithium titanate(Li4Ti5O12, LTO) has been considered as a promising anode candidate because of its unique safety features, excellent cyclability, high thermal stability, stable working voltage, and no lithium dendrites or less solid electrolyte interphase (SEI) formation. Although it has an affordable theoretical capacity (∼175 mAhg-1), the delivered capacity is often much lower because of its sluggish Li+ diffusivity (10-9–10-13 cm2s-1) and poor electrical conductivity (∼10-13 Scm−1). To overcome this drawback, numerous efforts have been devoted concerning synthesizing special morphology or introducing extrinsic point defects by doping foreign elements.

In our previous study, the LTO powders were synthesized by modified solid-solution method. Atmospheric pressure plasmas (APPs) jet device was set up as doping source with different gas, which is then subjected to the electrode processing route. Plasma-treated LTO electrodes was successfully doped by N ions into O site through Ar/N2 atmospheric pressure plasma, and exhibited a desirable discharge capacity of 132 mAhg-1 with almost 100% capacity retention after 100 cycles at a high rate of 10C. In addition, many studies show that carbon over-layer coating can greatly accelerate their rate capability and suppress irreversible reaction. Therefore, in this work, to further improve the possibility of industrialization, commercialized LTO is used as host material. After preparing LTO electrode, Ar/N2 atmospheric pressure plasma with carbon rod as working electrode is applied. With this method, the effect of carbon and nitrogen co-doping could be reached in one step. After treatment, the capacity can be greatly enhanced from 50mAhg-1 to almost 120mAhg-1 at 10C, and retention as compared to 1st cycle can reach 94.3% after 300 cycles. It is hoped that the development of plasma treatment in LTO anode materials would exhibit a great potential to meet the demand of next generation high power Li-ion battery.

References:

[1] Chun-Kai Lan, Shang-I. Chuang, Qi Bao, Yen-Ting Liao, Jenq-Gong Duh, Journal of Power Sources 275 (2015) 660−667, One-step argon/nitrogen binary plasma jet irradiation of Li4Ti5O12 for stable high-rate lithium ion battery anodes