**Supporting Information**

**Structural properties and electrochemical performance of different polymorphs of Nb2O5 in magnesium-based batteries**

Cunyuan Peia, Yameng Yina, Xiaobin Liaoa,b, Fangyu Xionga, Qinyou Ana,c,\*, Mengda Jina, Yan Zhaob,\*, Liqiang Maia,c,\*

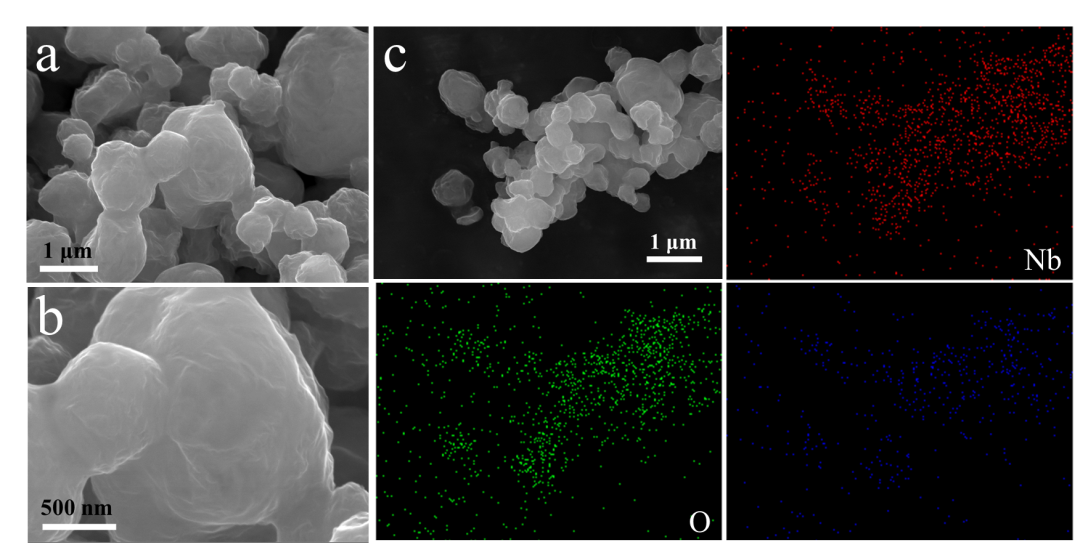
a *State Key Laboratory of Advanced Technology for Materials Synthesis and Processing, Wuhan University of Technology, Wuhan 430070, Hubei, China*

b *State Key Laboratory of Silicate Materials for Architectures, International School of Materials Science and Engineering, Wuhan University of Technology, Wuhan 430070, Hubei, China*

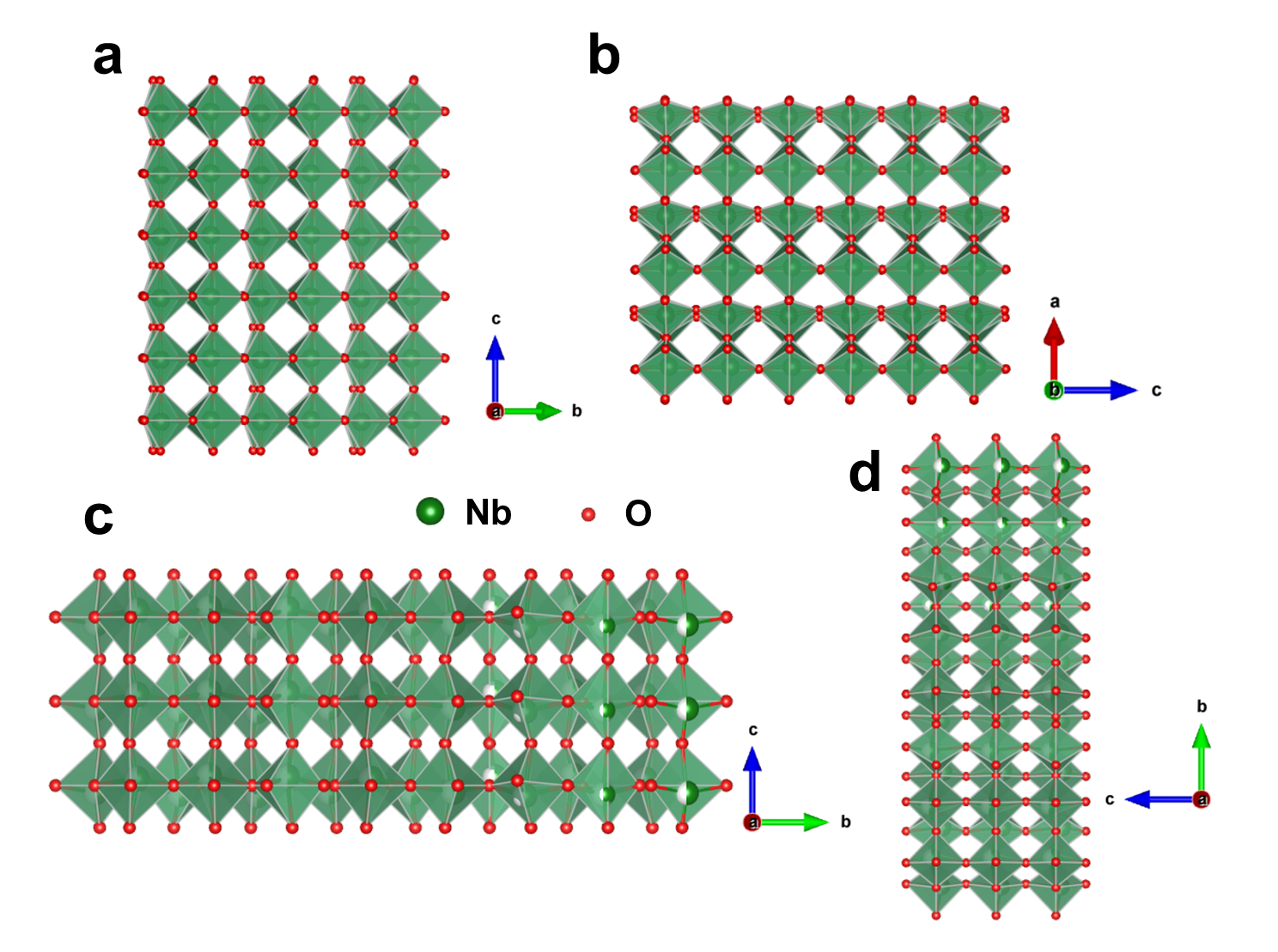
c *Foshan Xianhu Laboratory of the Advanced Energy Science and Technology Guangdong Laboratory, Xianhu hydrogen Valley, Foshan 528200, Guangdong, China*

*\*Corresponding authors.*

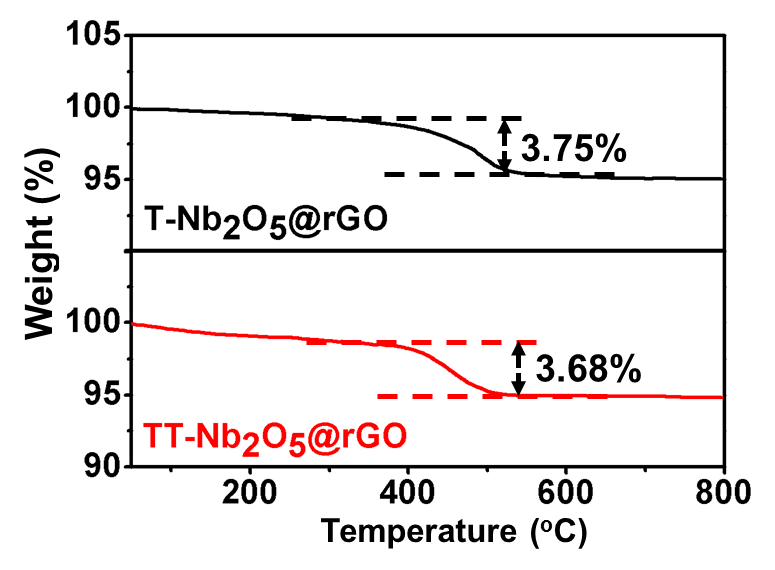
E-mail: anqinyou86@whut.edu.cn (Q. An), yan2000@whut.edu.cn (Y. Zhao), mlq518@whut.edu.cn (L. Mai)



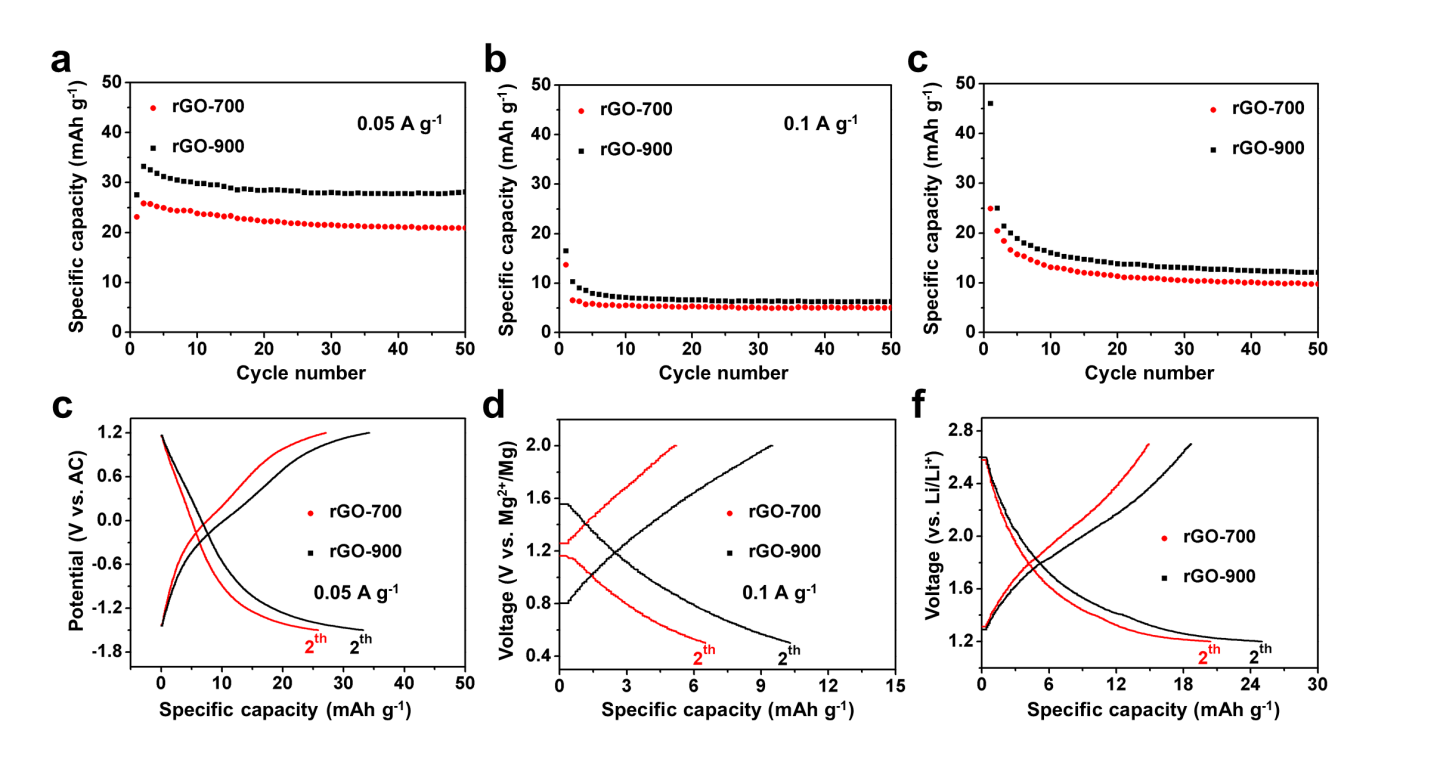
**Fig. S1** SEM images (a, b) and EDS elemental mapping images (c) of Nb*x*O*y*@GO composite before calcination.



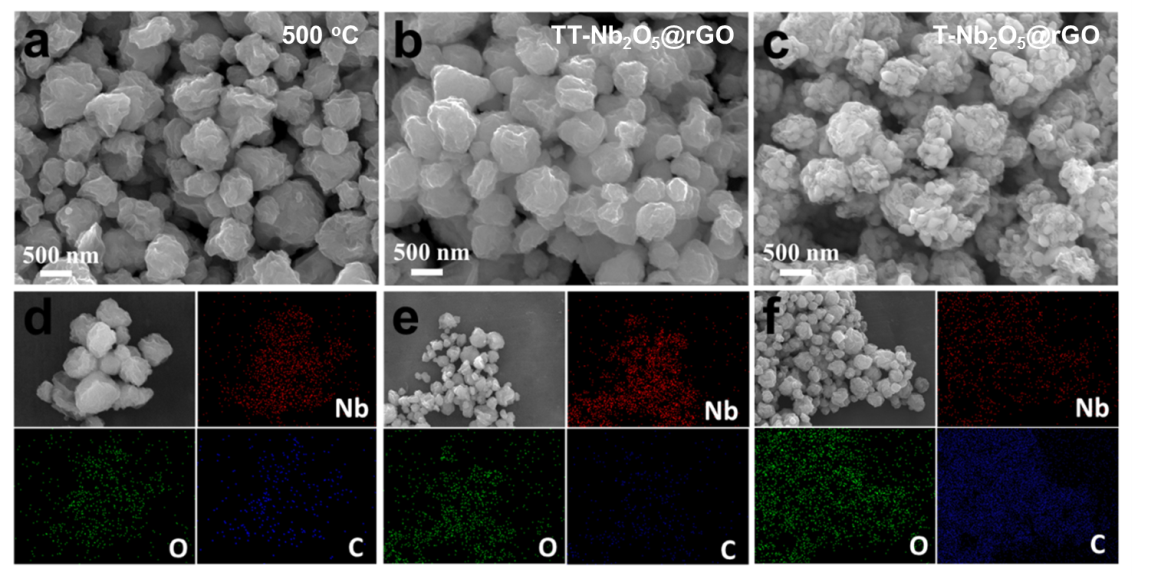
**Fig. S2** Crystal structures of (a, b) TT-Nb2O5 and (c, d) T-Nb2O5.



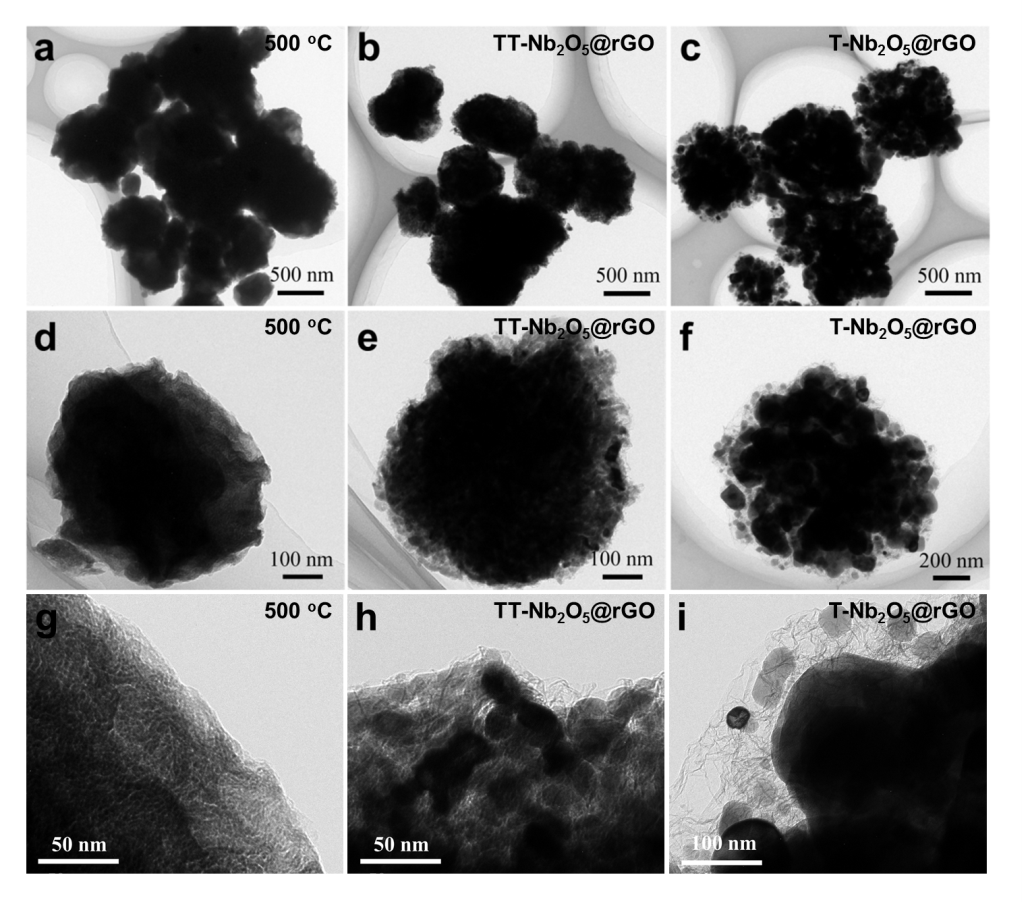
**Fig. S3** TG curves tested under air condition.



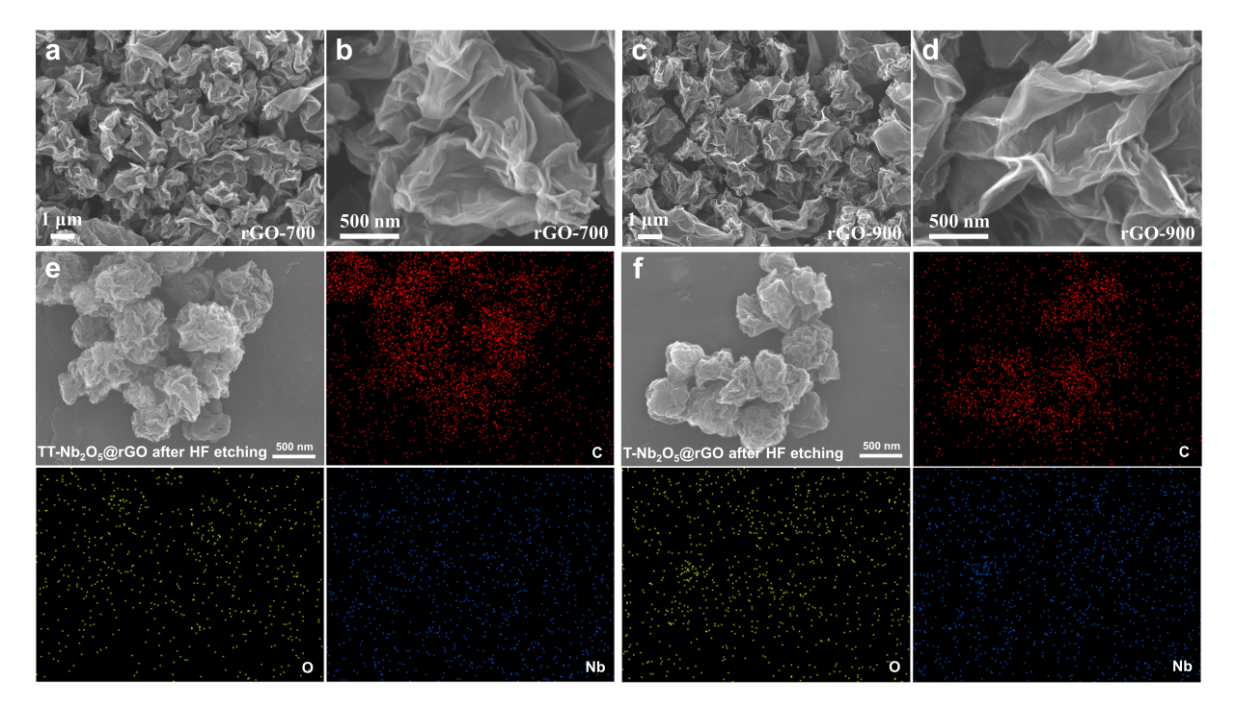
**Fig. S4** The electrochemical performance of rGO annealing at 700 and 900 οC as electrode for (a, c) Mg-storage (in 0.3 M Mg(TFSI)2/DME electrolyte against AC anode) and (b, d) Li-storage (in APC-LiCl electrolyte against Mg metal anode).



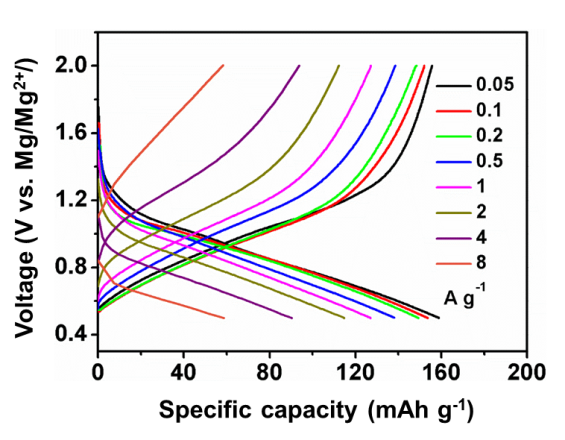
**Fig. S5** SEM images and elemental mappings of the samples after annealing at 500 οC (a, d), 700 οC (b, e) and 900 οC (c, f).



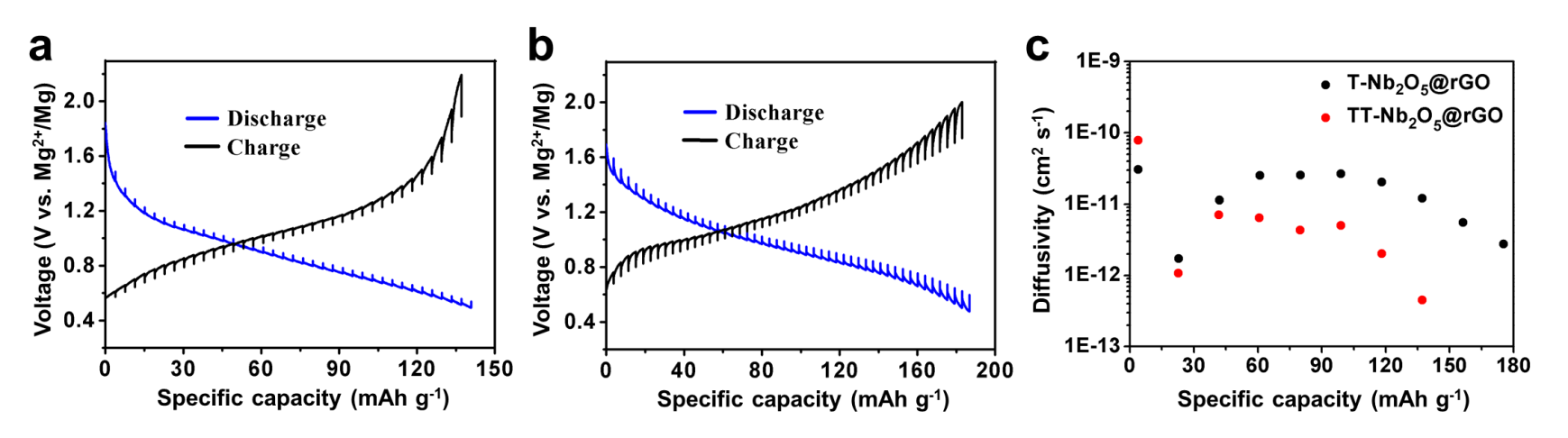
**Fig. S6** TEM and HRTEM images of the sample after annealing at 500 οC (a, d, g), 700 οC (b, e, h) and 900 οC (c, f, i).



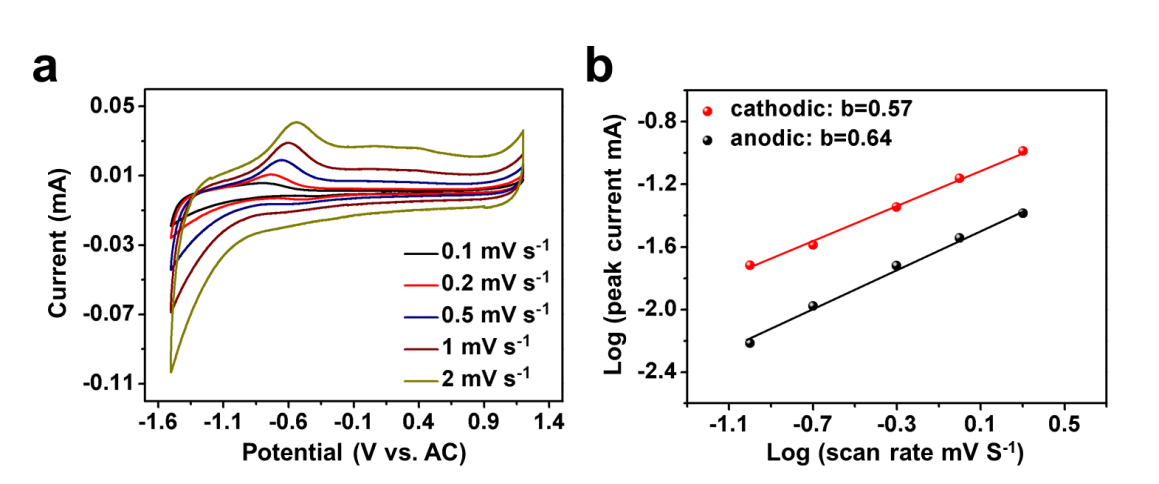
**Fig. S7** The SEM images of pure rGO annealing at (a, b) 700 oC and (c, d) 900 oC. The SEM images and elemental mappings images of (e) TT-Nb2O5@rGO and (f) T-Nb2O5@rGO after HF etching.



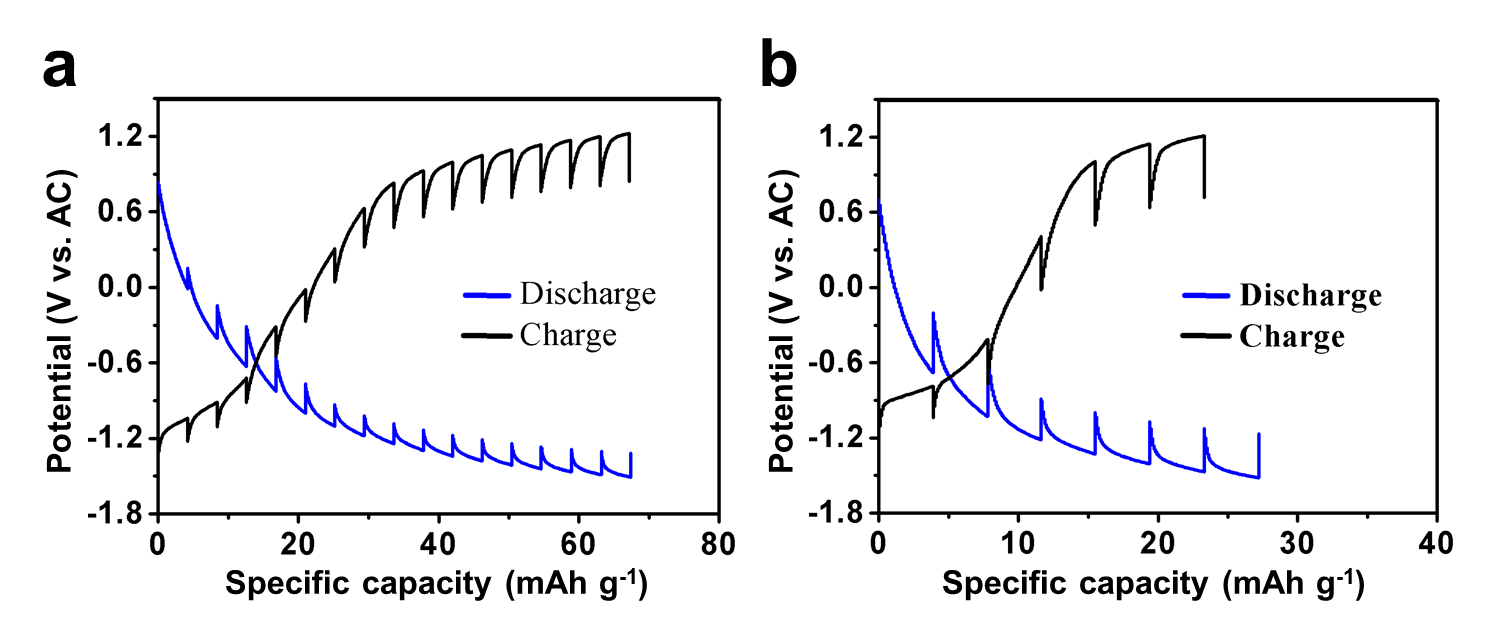
**Fig. S8** Discharge-charge curves of T-Nb2O5@rGO at various current densities.



**Fig. S9** The GITT curves of (a) TT-Nb2O5@rGO and (b) T-Nb2O5@rGO for Li-storage.



**Fig. S10** (a) CV curves of TT-Nb2O5 electrode at different scan rates from 0.1 to 2 mV s-1. (b) Determination of the *b* value by the plot of log (*i*) vs log (*v*).



**Fig. S11** The GITT curves of (a) T-Nb2O5@rGO and (b) TT-Nb2O5@rGO for Mg-storage.