#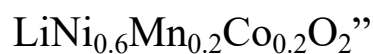 Supplementary Information for "Correlated biphasic features of the improved rate capability upon Ga doping in $LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$"

Jie Li[1], Zhimin Li[1,1], Maolin Zhang[1], Yangxi Yan[1], Dongyan Zhang[1,2], Pangpang Wang[2], Ri-ichi Murakami[3]

[1]School of Advanced Materials and Nanotechnology, Xidian University, Xi'an 710126, P. R. China

[2]Nanomaterials Group, Institute of System, Information Technologies and Nanotechnologies (ISIT), Fukuoka Industry-Academia Symphonicity (FiaS), 4-1 Kyudaishinmachi, Nishi-ku, Fukuoka 819-0388, Japan

[3]School of Mechanical Engineering, Chengdu University, Chengdu 610106, P. R. China

1 zmli@mail.xidian.edu.cn
2 zhangdongyan@xidian.edu.cn

Table S1. 100 cycle capacity retention of NCM622 with and without Ga doping in the voltage

range of 2.7-4.5 V

Ga content	0%	0.5%	1%	3%
Retention	68.47%	66.91%	80.46%	80.82%

Table S2. 100 cycle capacity retention of NCM622 with and without Ga doping in the voltage

range of 3.5-4.3 V

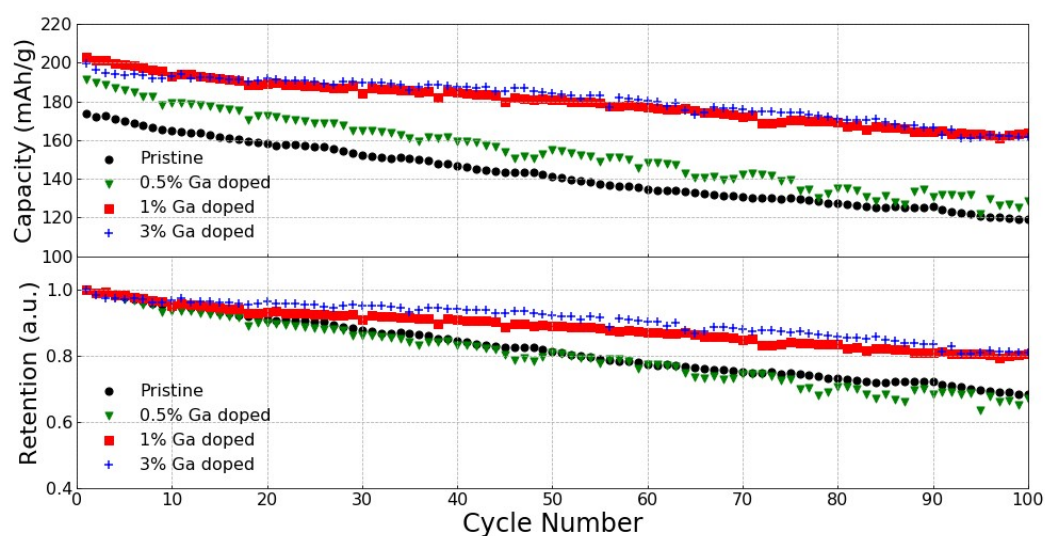| Ga content	0%	0.5%	1%	3%
Retention	72.97%	90.09%	92.36%	91.41%

Figure S1. (a) Cyclic discharge capacity, (b) capacity retention, at 1 C of Ga doped and undoped
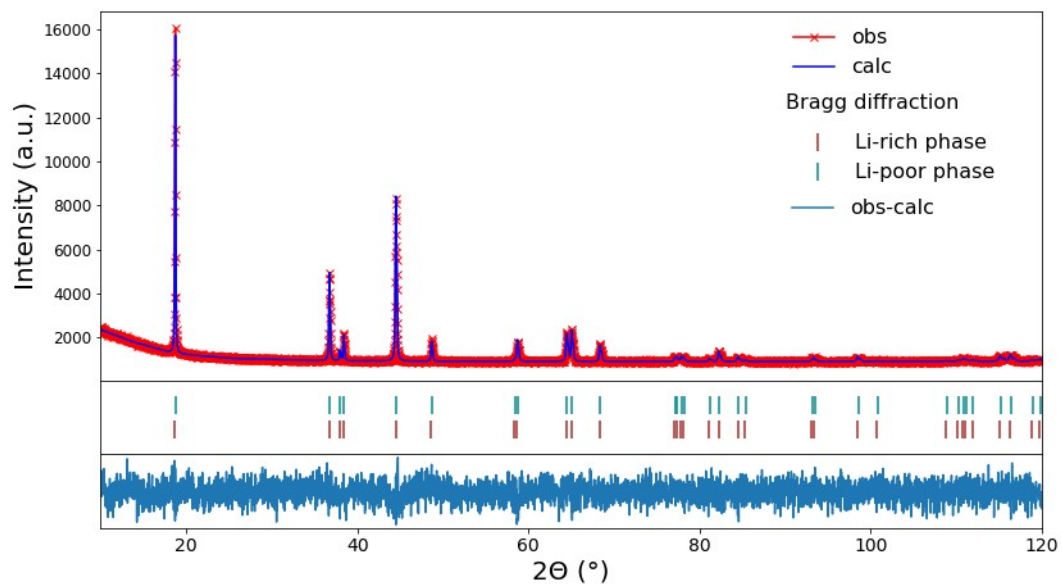
NCM622 in the voltage range of 2.7-4.5 V.

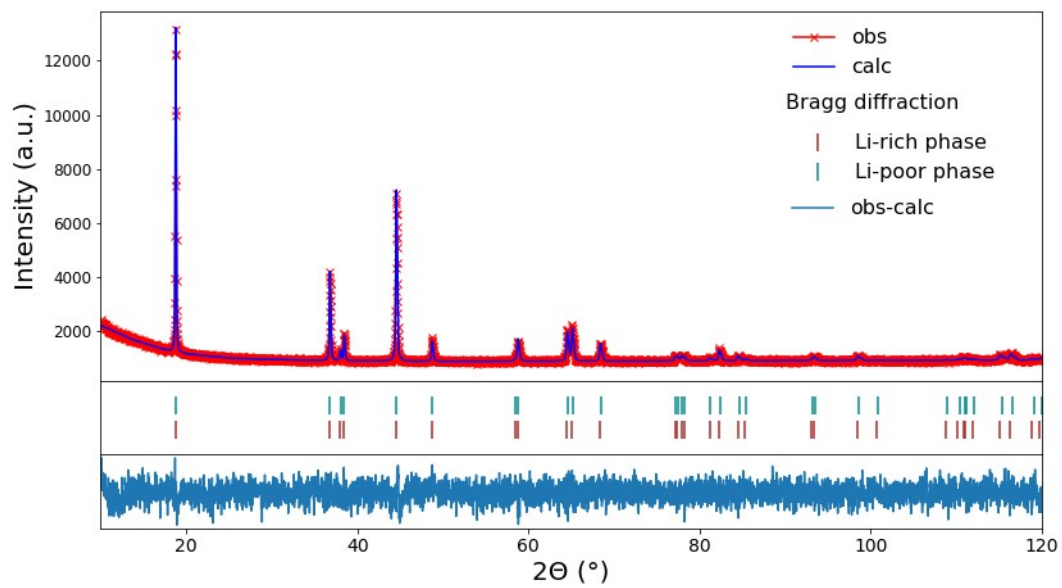Figure S2. Rietveld refinement of XRD pattern for NCM622 without Ga doping.

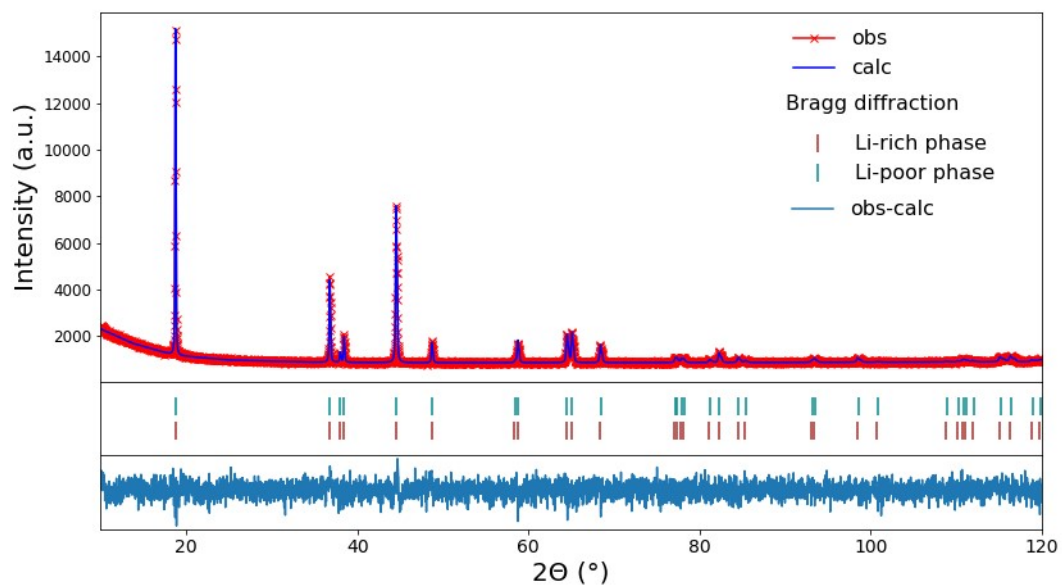Figure S3. Rietveld refinement of XRD pattern for NCM622 with 0.5% Ga doping.

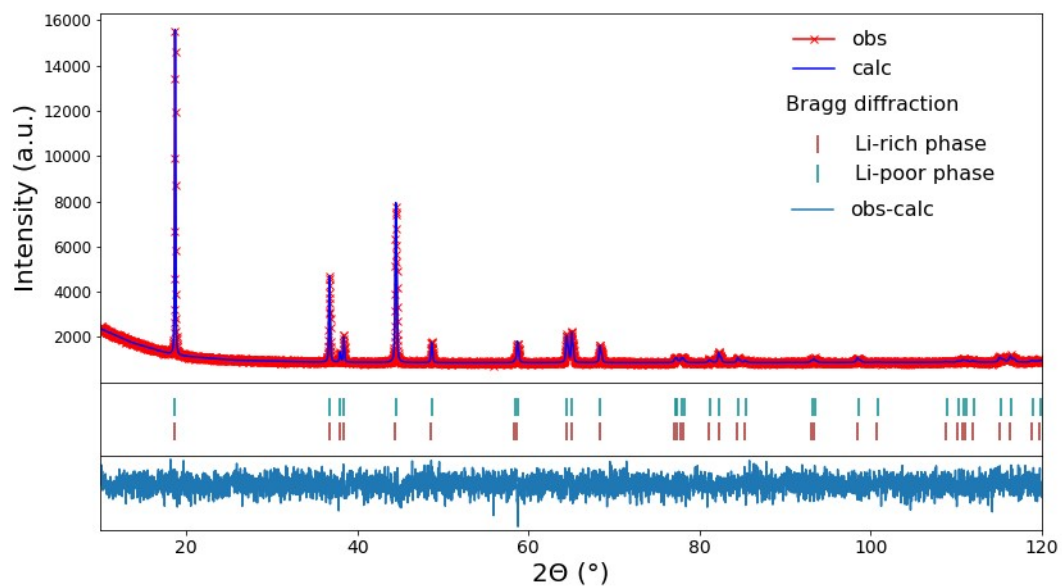Figure S4. Rietveld refinement of XRD pattern for NCM622 with 1% Ga doping.

Figure S5. Rietveld refinement of XRD pattern for NCM622 without Ga doping.
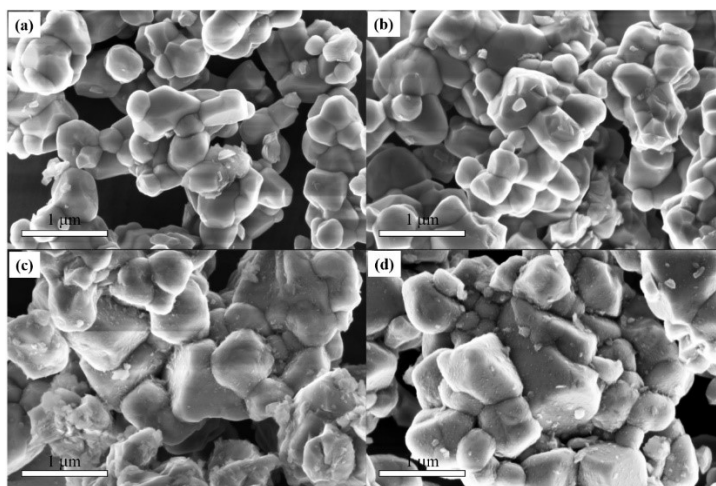
Figure S6. SEM micrographs of (a) 0%, (b) 0.5%, (c) 1%, (d) 3% Ga doped NCM622.
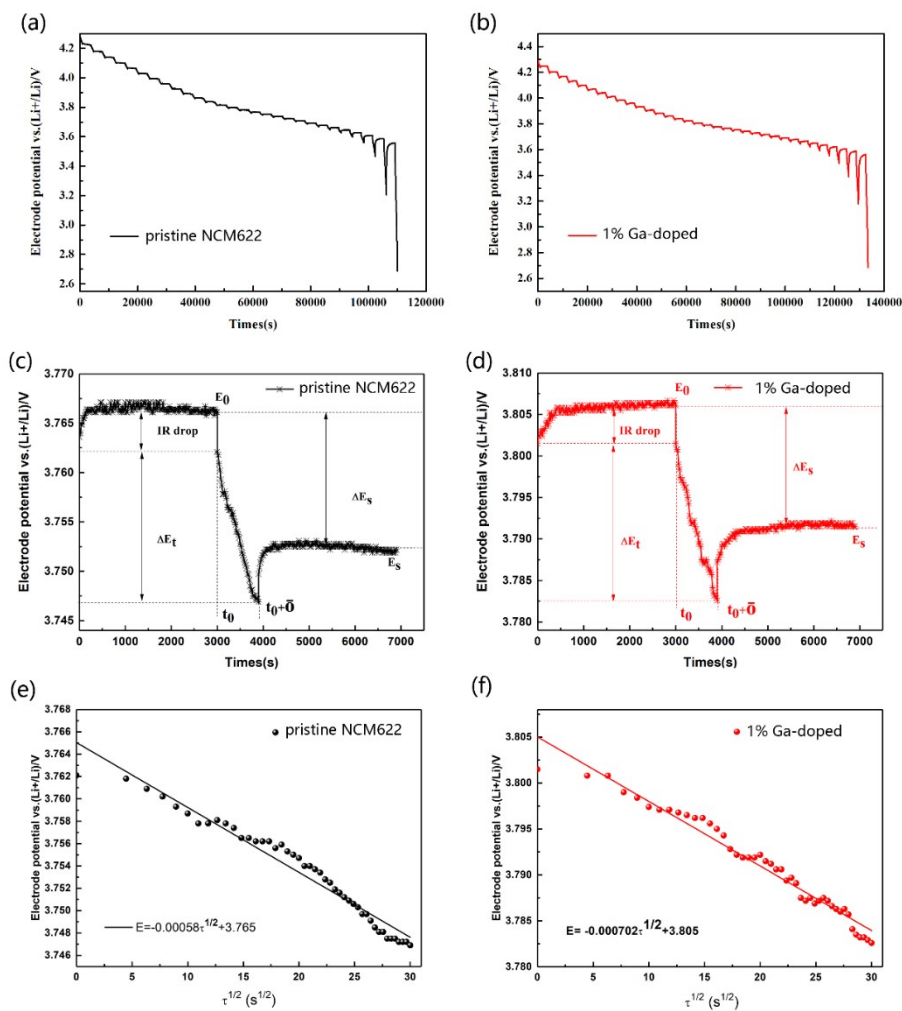

Figure S7. (a-b) GITT curves for the discharge of the prepared samples, (c-d) applied current plus

vs cell voltage for a single titration step of GITT curves, (e-f) linear fit of the cell voltage as a

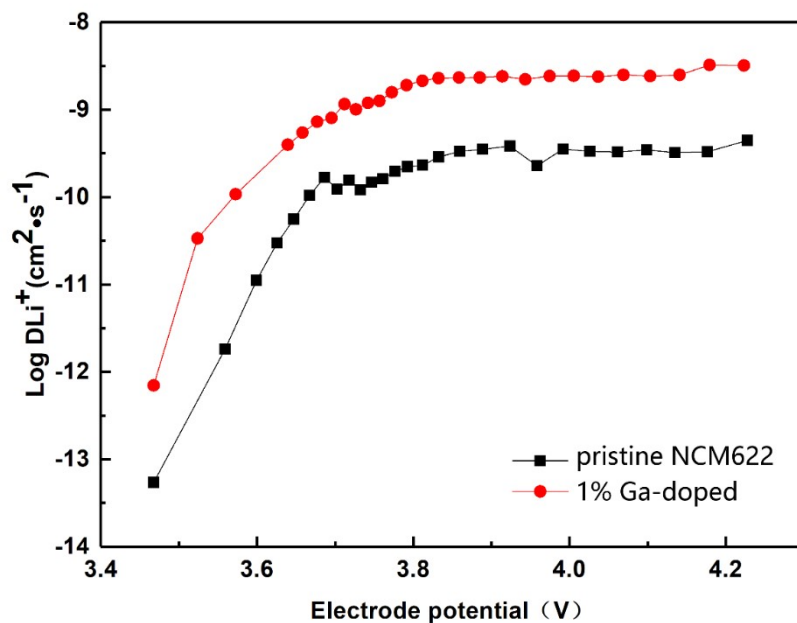function of the square root of time ($\tau^{1/2}$) with different pulse current.

Figure S8. The chemical diffusion coefficient of Li$^+$ as function of potential for NCM622 with and

without Ga doping during discharge process.

Table S3. Calculated diffusion coefficient from EIS for NCM622 with and without Ga doping.

Ga content	Diffusion coefficient (cm^2/s)	
	Before cycling	After 100 cycles
0%	1.28×10^{-9}	6.31×10^{-10}
1%	1.567×10^{-9}	9.48×10^{-10}