High capacity DG silicon electrode

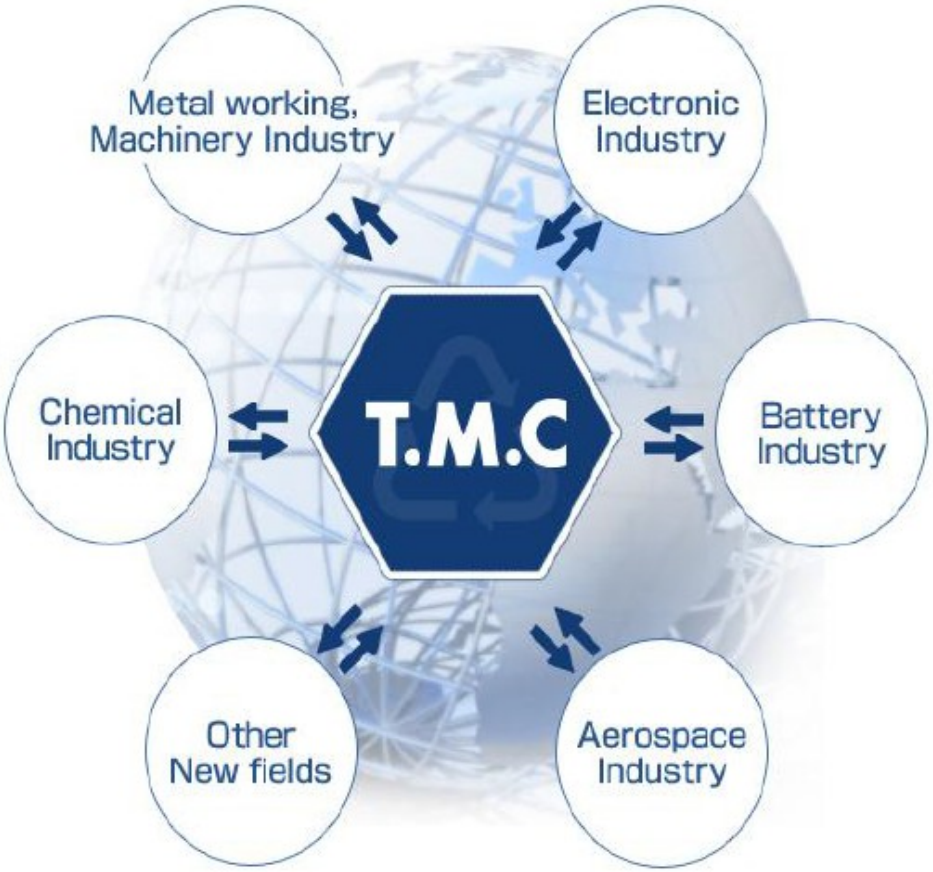
Town Mining Co., Ltd.
Daichi Iwanari , Kazuma Yoshida , Kazuyoshi Tanaka

National Institute of Advanced Industrial Science and Technology
Takashi Mukai , Tetsuo Sakai

What is T.M.C ?

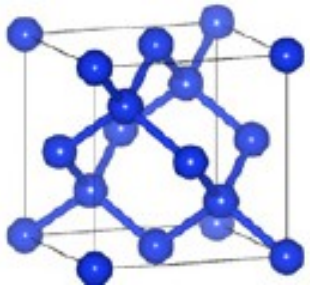
T.M.C → Town mining Co.,Ltd

TMC is doing the recycling of rare metals.



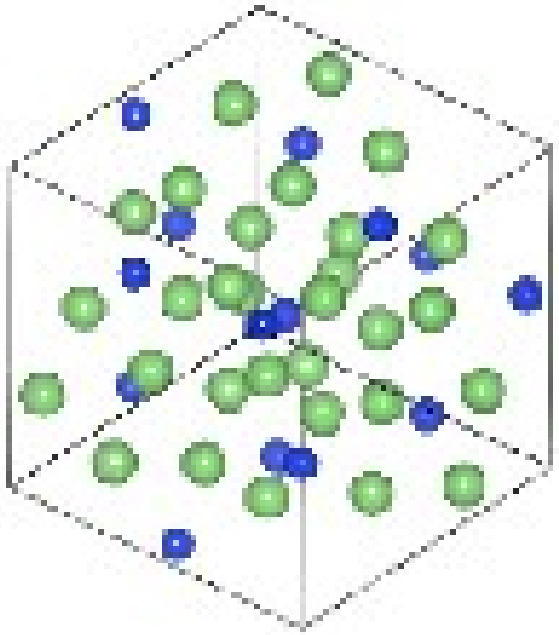
AIST T.M.C

Si anode material



Si

3600mAhg^{-1}



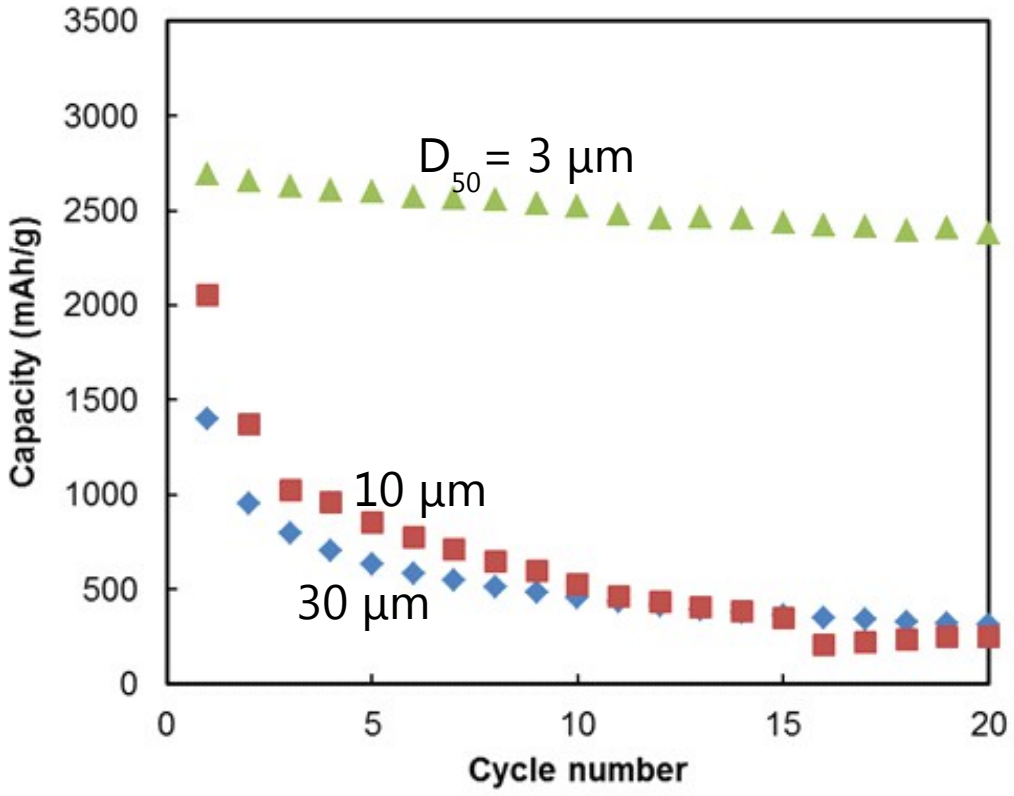
$Li_{15}Si_4$ ($Li_{3.75}Si$)

Theoretical capacity is large. Volume change is also large.

AIST T.M.C

For the particle size of the Si powder

Cycle performance of machinery milled silicon (MM silicon) electrode having a different average particle sizes.



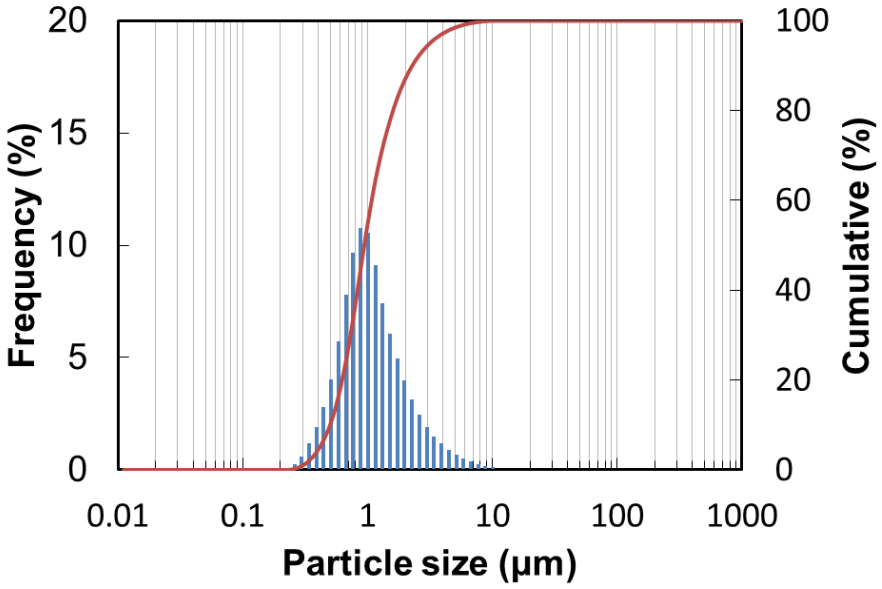
Shows a poor electrode performance when using larger particles.

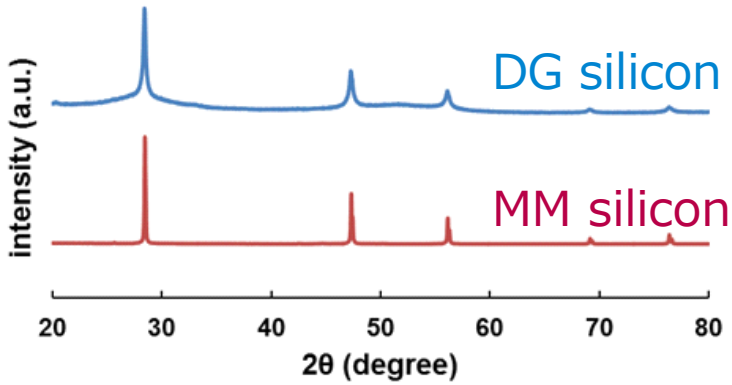
Small particle size Si powder is more expensive than large particle size Si.

AIST T.M.C

What is DG silicon?

DG silicon was obtained without milling step from the manufacturing process of high-purity silicon wafer.





D_{50} = 1.3 μm

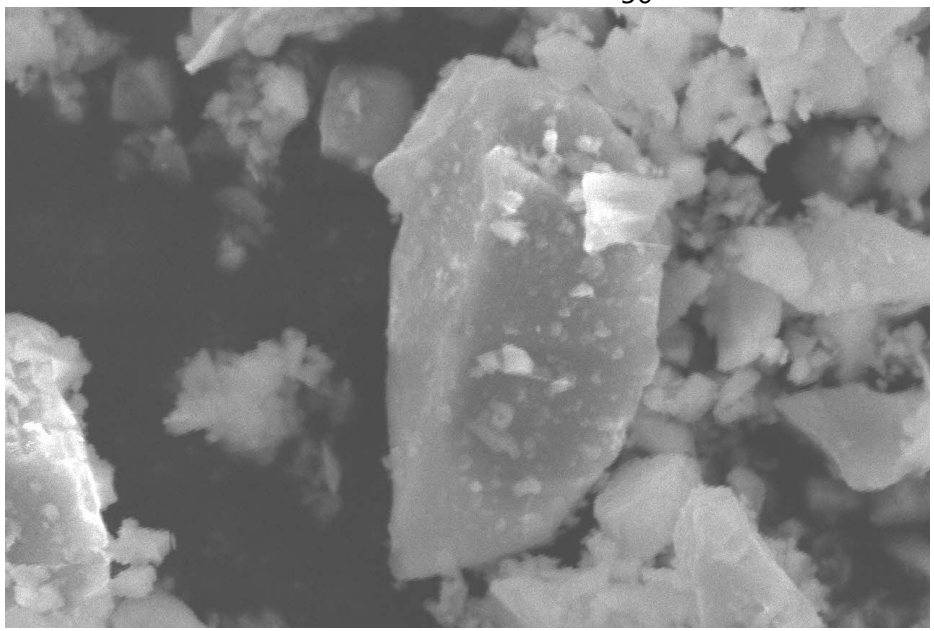
Crystallite size = 30 nm

Specific surface area = 21 m^2/g

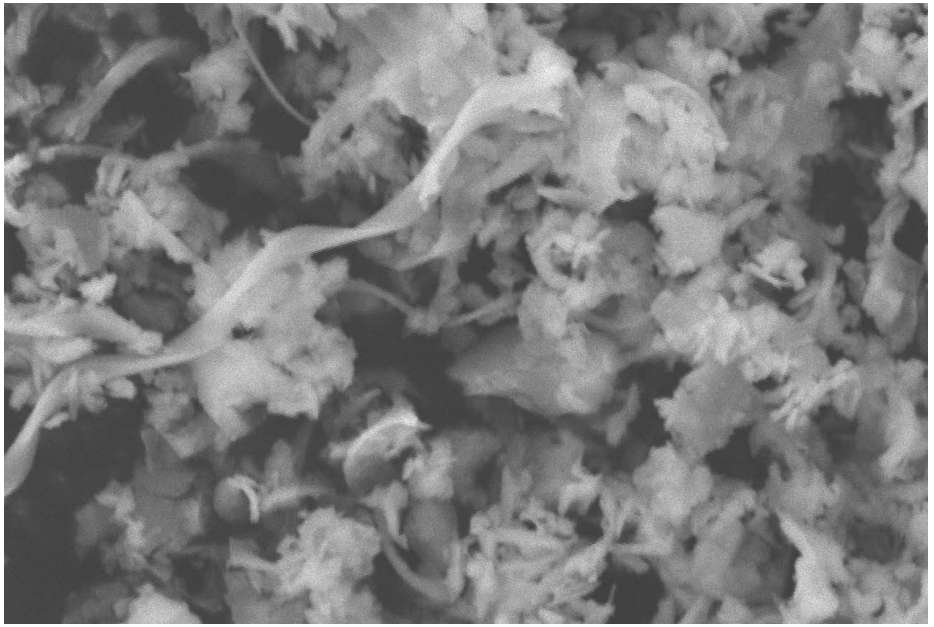
AIST T.M.C

SEM image of the DG silicon powder

MM silicon powder (D_{50}=3μm)



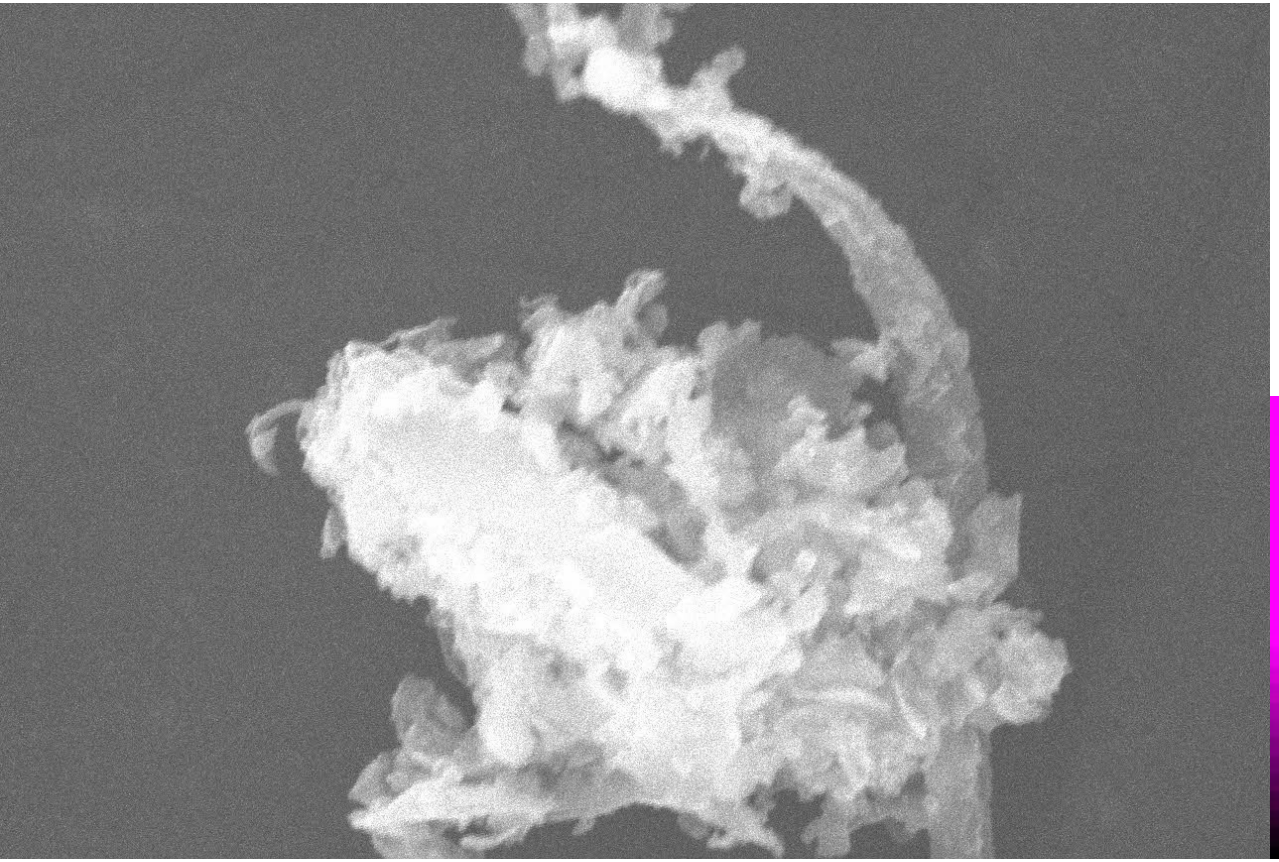
DG silicon powder (D_{50}=1.3μm)



×10000 — 1 μm

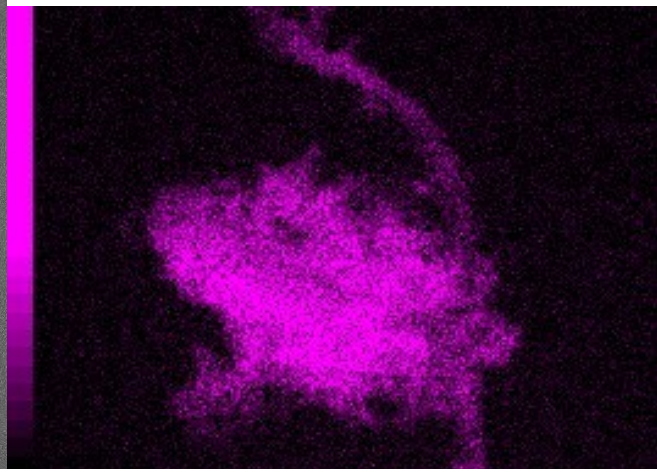
EDS mapping of the DG silicon powder

SEM image



1 μm

Si

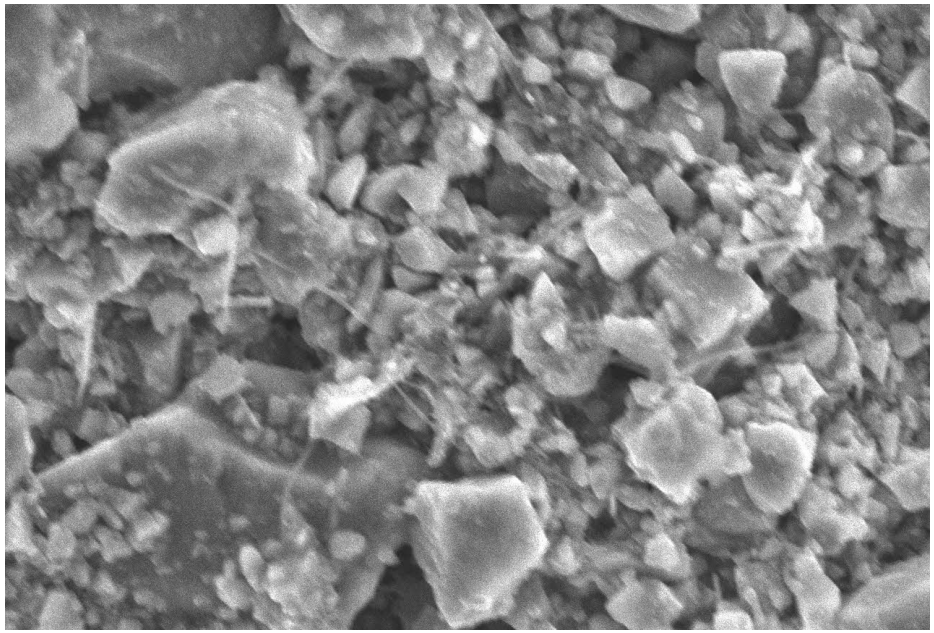


3 μm

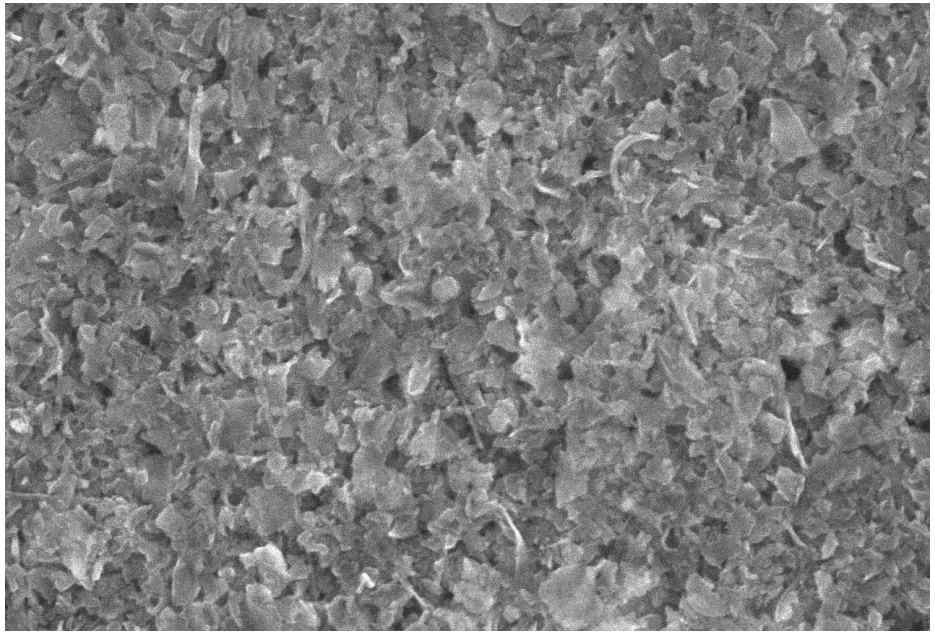
AIST T.M.C

SEM image of the DG silicon electrode

MM silicon electrode



DG silicon electrode



×5000 5 μm

Composition of slurry

Si : Ketjenblack : VGCF : Polyimide binder = 79 : 1 : 2 : 18

Drying condition

250 ℃ 3h under vacuum conditions

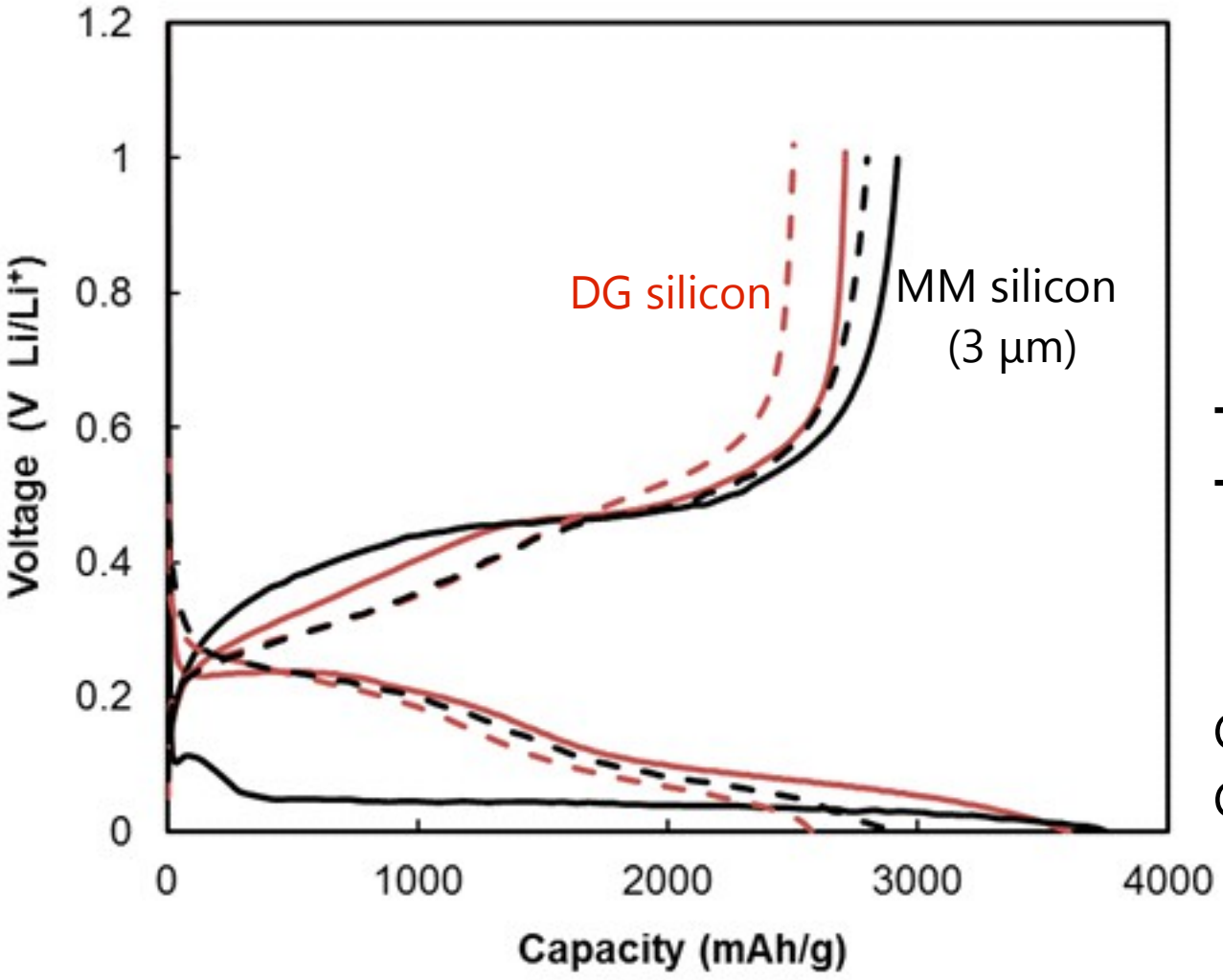
AIST T.M.C

Charge-discharge test conditions

Type of cell	CR2032 Coin-type cell
Size of the electrode	11φmm
Electrolyte	1 M $LiPF_6$ EC:DEC (1:1 vol%)
Separator	Glass separator
Cut-off potential	0-1 V vs. Li/Li^+
Current	0.5 CA
Temperature	30℃

AIST T.M.C

Charge discharge curves of DG silicon electrode

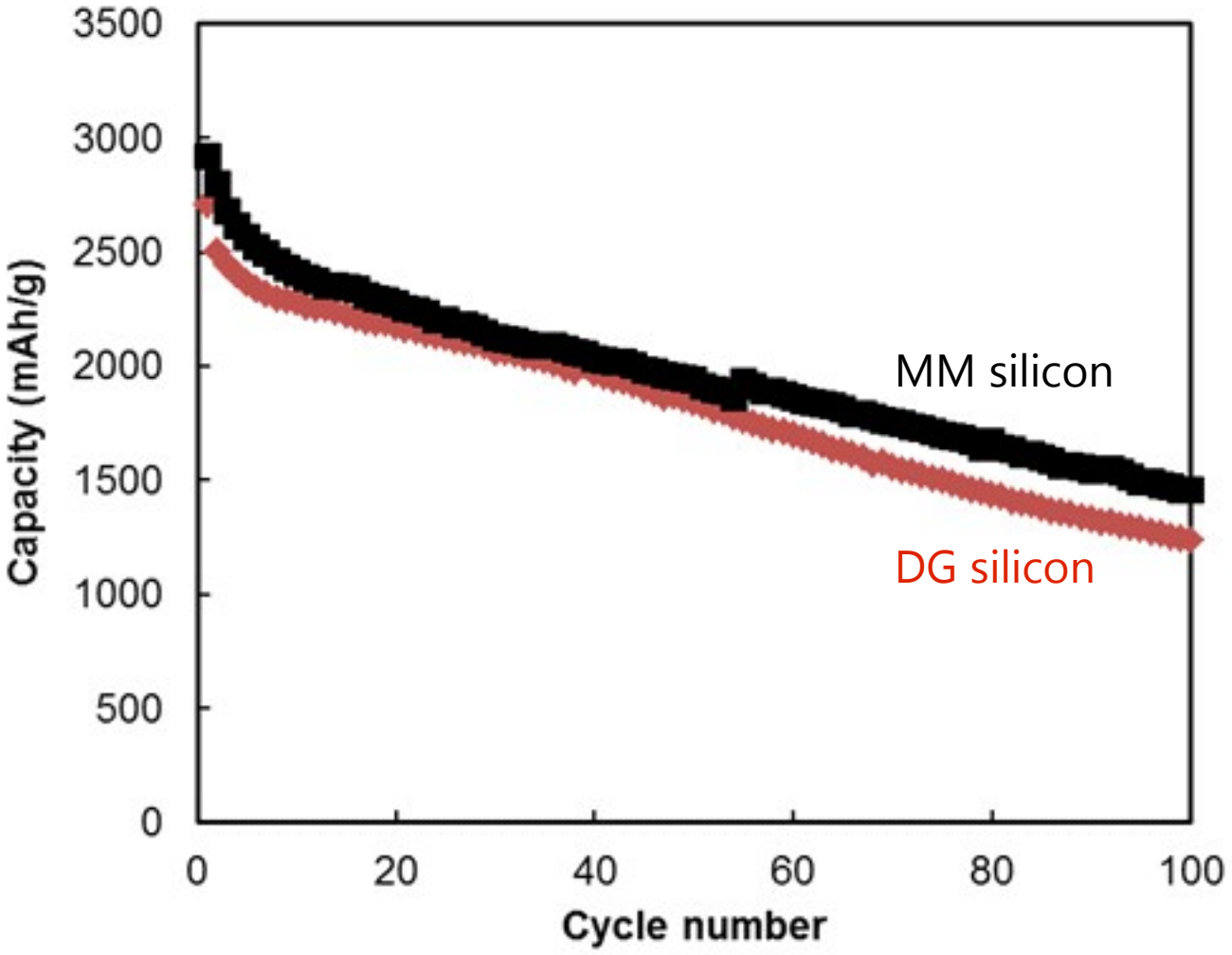


Current 0.5 CA

Capacity 3.0 mhA/cm^2

AIST T.M.C

Cycle performance of DG silicon electrode

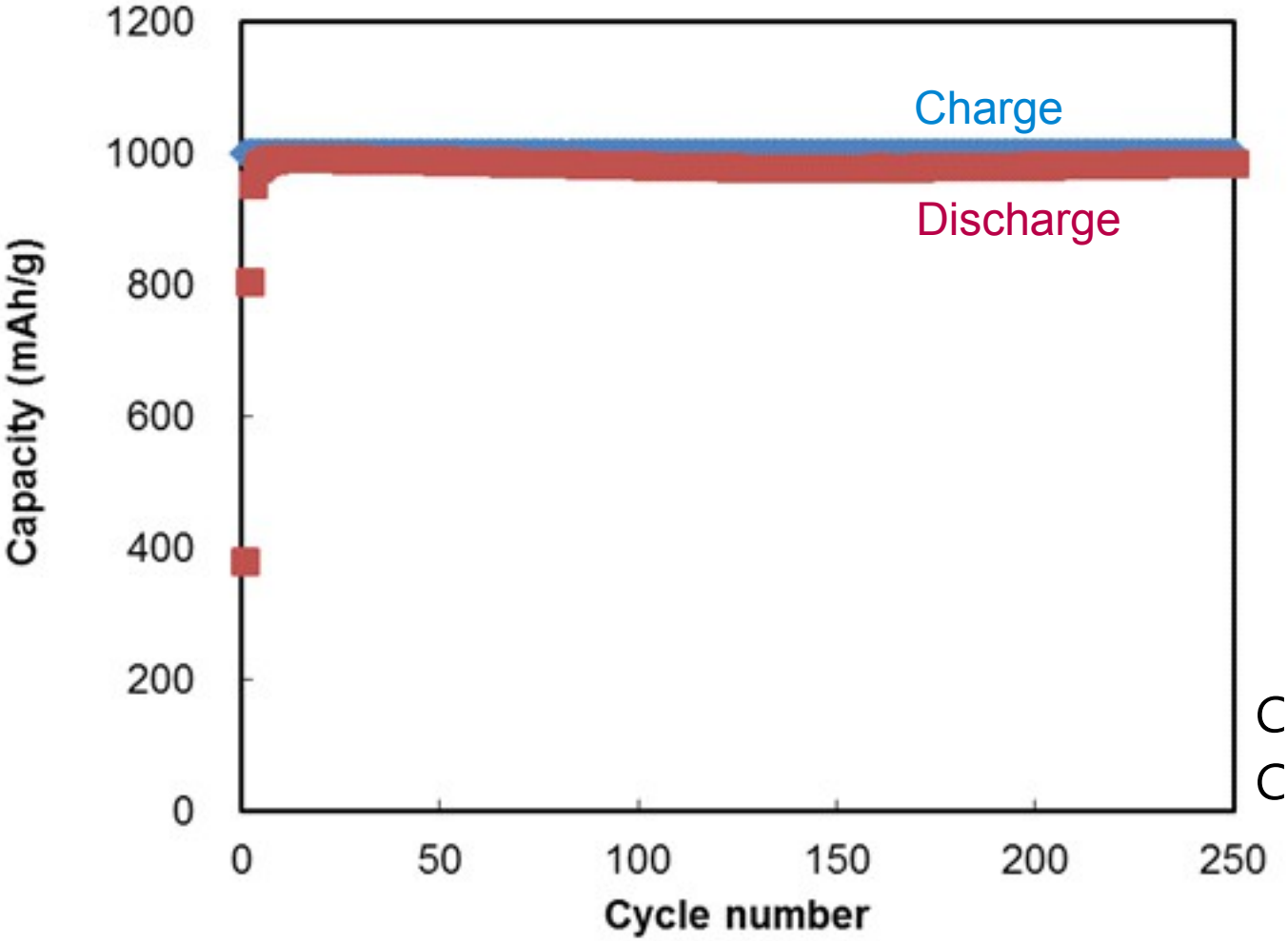


Current 0.5 CA

Capacity 3.0 mhA/cm^2

AIST T.M.C

Effect of capacity limitation



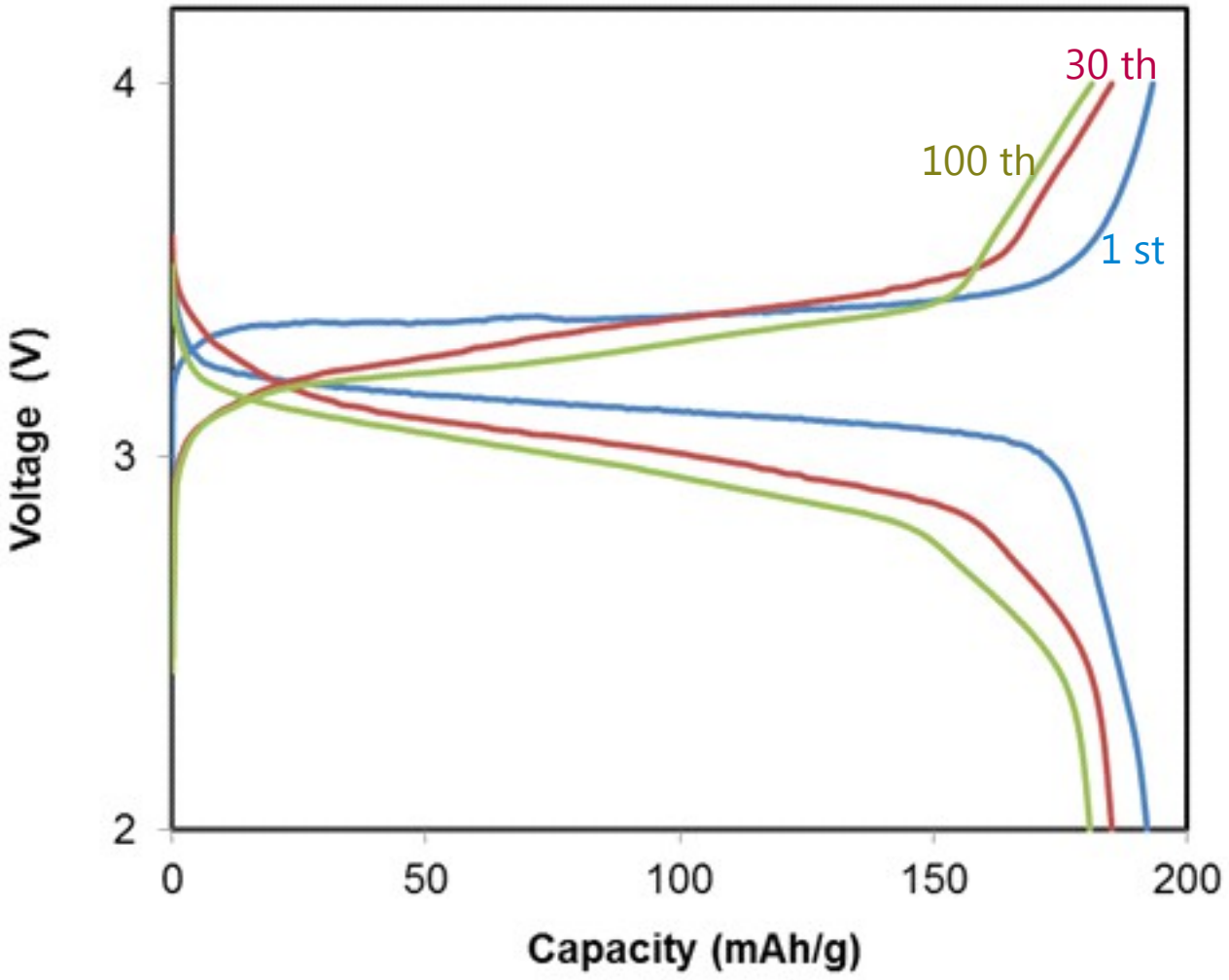
Current 0.5 CA

Capacity 3.0 mhA/cm^2

AIST T.M.C

Test results for the full cell | Charge discharge curves

$LiFePO_4$ was used as a positive electrode active material.



Current 0.5 CA

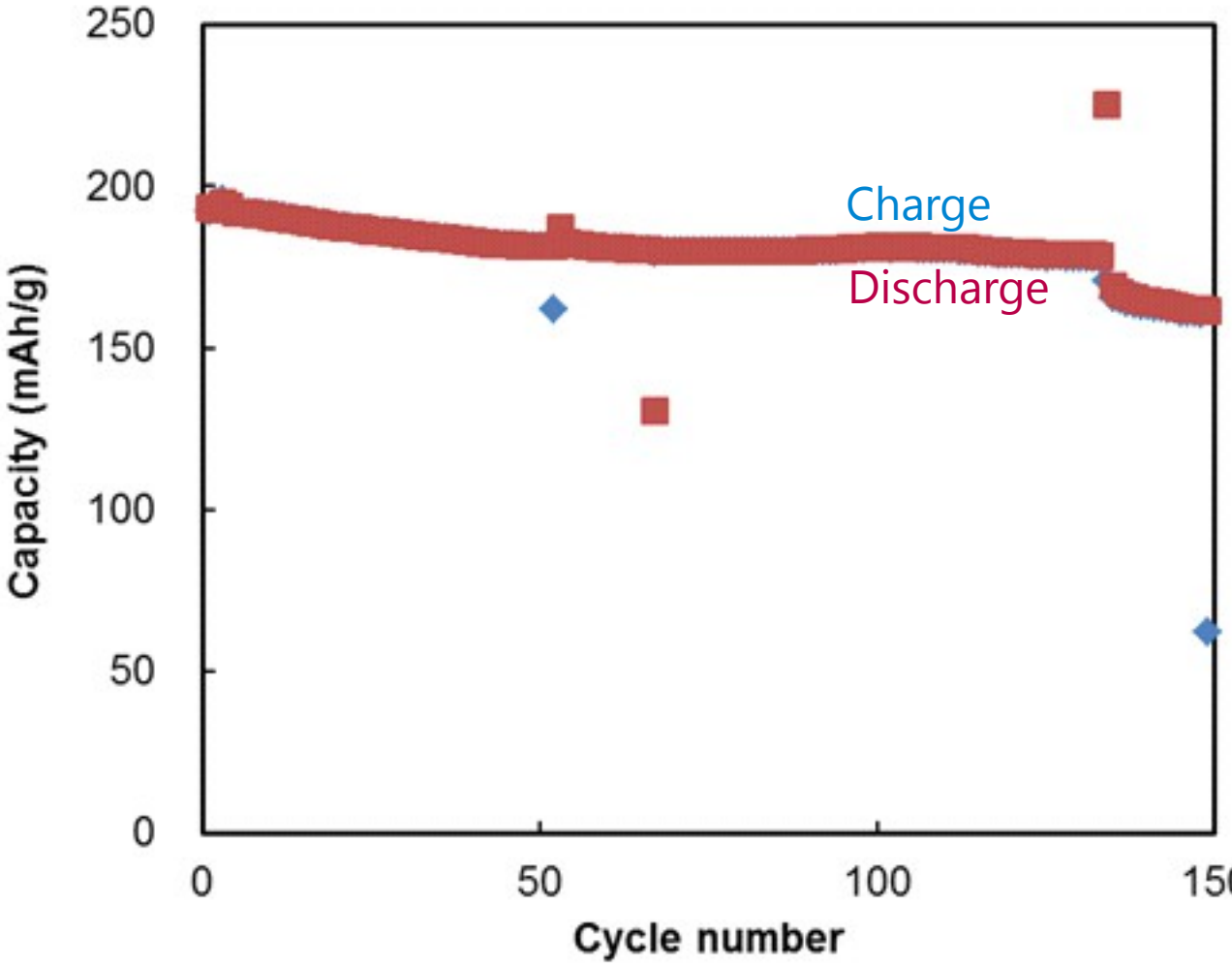
Electrode capacity

Negative 3.0 mhA/cm^2

Positive 1.0 mhA/cm^2

AIST T.M.C

Test results for the full cell | Cycle performance



Current 0.5 CA

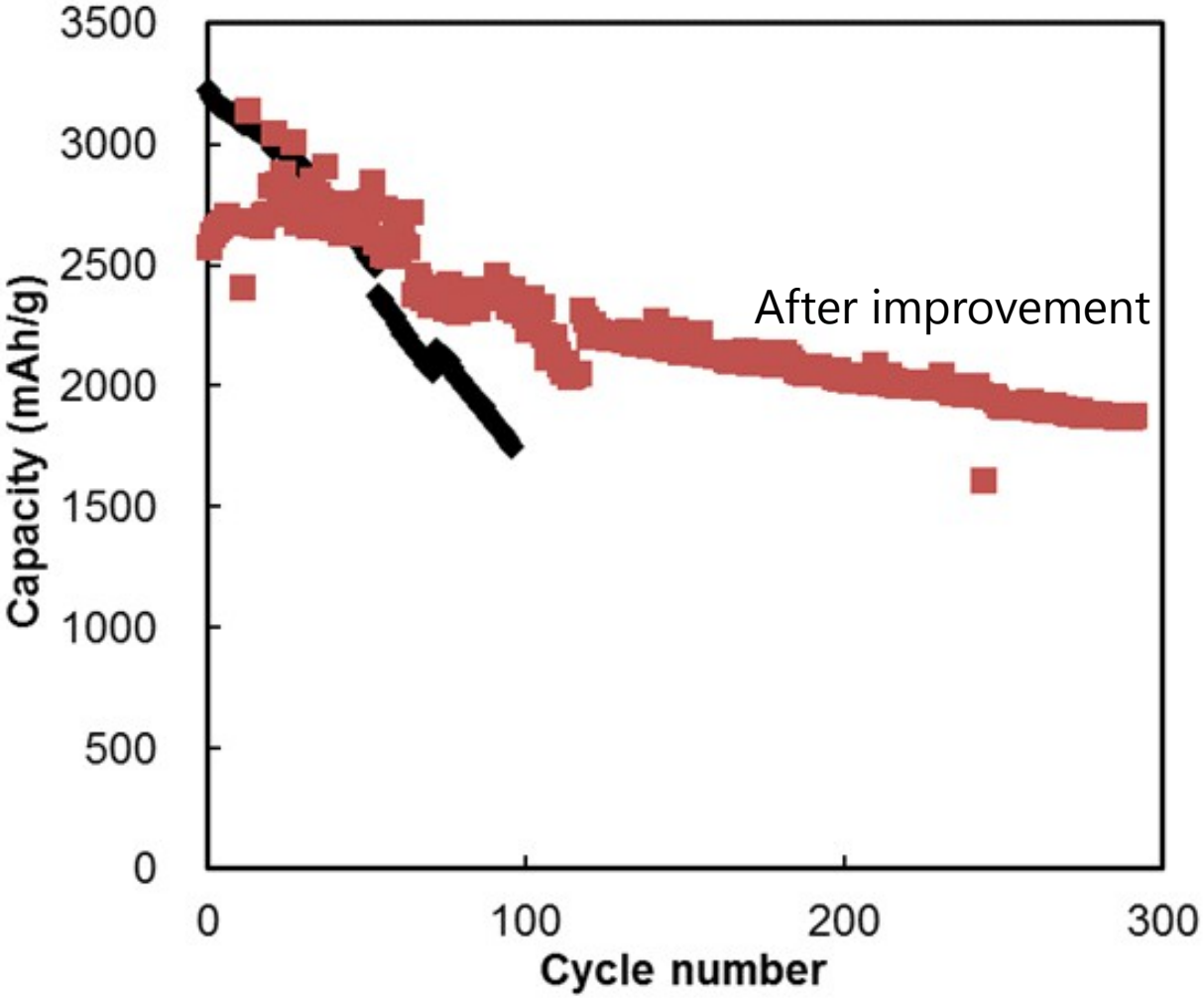
Electrode capacity

Negative 3.0 mhA/cm^2

Positive 1.0 mhA/cm^2

AIST T.M.C

Further improvement



Current	0.2 CA
Thickness	7 μm
Capacity	3.0 mhA/cm^2

AIST T.M.C

Conclusion

DG silicon was powder having an average particle size of 1.3μm.

Surface of the electrode made of DG silicon is smoother than that of MM silicon.

Cycle performance of DG silicon electrode was equivalent to MM silicon electrode.

Cycle performance of DG silicon electrode were improved under capacity limitation.

AIST T.M.C

T.M.C TOWN MINING CO.,LTD.