Electronic Supplementary Material

SnO_2/Graphene Composite with High Lithium Storage Capability for Lithium Rechargeable Batteries

Haegyeom Kim[1], Sung-Wook Kim[2], Young-Uk Park[2], Hyeokjo Gwon[2], Dong-Hwa Seo[2], Yuhee Kim[4], and Kisuk Kang[1, 2, 3] (✉)

[1] Graduate School of Energy, Environment, Water, and Sustainability, Korea Advanced Institute of Science and Technology (KAIST), 335 Gwahangno, Yuseong-gu, Daejeon 305-701, Republic of Korea
[2] Department of Materials Science and Engineering, KAIST, 335 Gwahangno, Yuseong-gu, Daejeon 305-701, Republic of Korea
[3] KAIST Institute for Eco-energy, Nanocentury, KAIST, 335 Gwahangno, Yuseong-gu, Daejeon 305-701, Republic of Korea
[4] Korea Institute of Science and Technology (KIST), 39-1 Hawolgok-dong, Wolsong-gil 5, Seongbuk-gu, Seoul 136-791, Republic of Korea

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Etching of Sn and its oxidation to SnO_2

In this study, we found that Sn metal was etched/oxidized in the reduction process. Either ammonia solution or hydrazine may etch/oxidize Sn metal to SnO_2 in the reduction process. To confirm which one etches/oxidizes Sn metal to SnO_2, we conducted additional experiments. Three samples were prepared. In the first one, 3800 μL of ammonia solution was added to 50 mg of Sn metal and 400 mL of DI water. In the second sample, 250 μL of hydrazine was added 50 mg of Sn metal and 400 mL of DI water. In the third sample, 3800 μL of ammonia solution and 250 μL of hydrazine were added to 50 mg of Sn metal and 400 mL of DI water. All the samples were subsequently heated to 500 ˚C for 4 h in an argon atmosphere. The three samples were analyzed by XRD and SEM.

Figure S-1 shows the XRD patterns of the samples. When hydrazine was used alone (Fig. S-1(c)), the diffraction peaks from Sn metal remained essentially unchanged. However, the samples prepared using

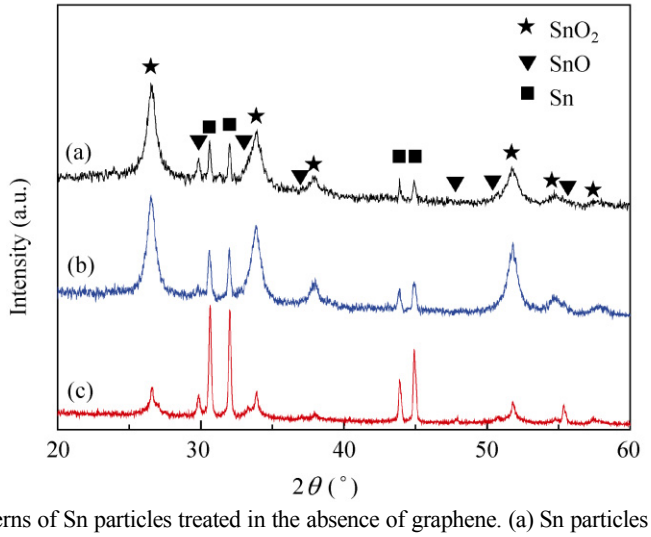

Figure S-1 X-ray diffraction patterns of Sn particles treated in the absence of graphene. (a) Sn particles treated with a mixture of hydrazine and ammonia, (b) Sn particles treated with ammonia only, and (c) Sn particles treated with hydrazine only

Address correspondence to matlgen1@kaist.ac.kr

ammonia solution alone (Fig. S-1(b)) or a mixture of ammonia and hydrazine (Fig. S-1(a)) showed diffraction peaks due to SnO_2, with a significant reduction in the intensity of the diffraction peaks due to Sn metal. From these results, we can conclude that ammonia solution acts as the agent for oxidizing Sn metal to SnO_2.

SEM images of the samples prepared by treating with hydrazine only and ammonia solution only are shown in Fig. S-2, with an SEM image of bare Sn metal for comparison. The morphology of the sample that was treated with hydrazine only (Fig. S-2(b)) was not significantly different from that of the bare Sn metal (Fig. S-2(a)), but that of the sample that was treated with ammonia solution only (Fig. S-2(c)) was significantly changed. In the sample prepared by treatment with ammonia solution, Sn metal was clearly etched. Thus, SEM confirms that ammonia solution acts as an etching agent for Sn metal.

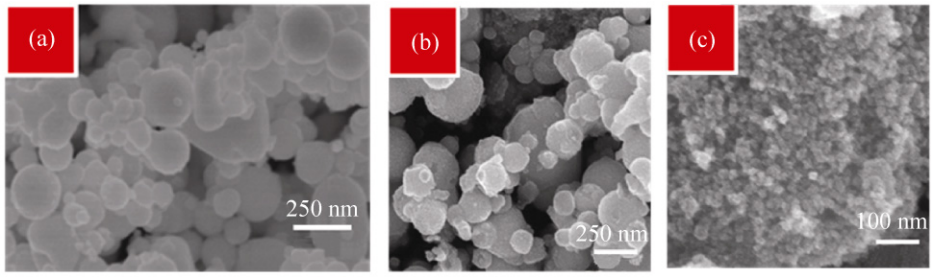

Figure S-2 SEM images of (a) bare Sn metal, (b) Sn particles after being treated with hydrazine only, and (c) Sn particles after being treated with ammonia solution only (experiments were carried out in the absence of graphene)