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多相交流アークにおける Li-W 複合酸化物ナノ粒子の生成機構

Formation Mechanism of Li-W Composite Oxide Nanoparticles in Multiphase AC Arc

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1. Introduction

A multiphase AC arc (MPA) is one of the most attractive thermal plasmas due to its advantages such as high energy efficiency, slow gas flow velocity, and large plasma volume, and is suitable for high-volume powder processing processes. However, due to their complex arc fluctuations [1], the fundamental phenomena during nanoparticle synthesis and product characteristics are insufficiently understood.

Surface coating with Li_2WO_4 nanoparticles on cathode material improves the capacity of lithium-ion battery [2]. The purpose of this study is to synthesize Li_2WO_4 nanoparticles by the multiphase AC arc. Another purpose is to investigate formation mechanism by elucidating the temperature field.

2. Experimental setup

The MPA was generated among 6 electrodes by applying sinusoidal voltages with different phases to multiple electrodes. A powder mixture of Li_2CO_3 and W was introduced into the plasma at a feed rate 0.8 g/min. Molar ratio of Li to W was adjusted at 2:1.

High-speed camera with appropriate band-pass filters at 400±5.0 nm and 505±5.0 nm were utilized to visualize W vapor. Excitation temperature of was estimated by the relative intensity ratio method.

3. Results and discussion

Figure 1 shows the XRD pattern of the produced nanoparticles by the multiphase AC arc. Results indicated that the Li_2WO_4 as target material was synthesized as major product, while W was also observed as minor product.

Figure 2 shows the temperature distributions by high-speed camera with appropriate band-pass filters. Obtained results indicated that the temperature of W vapor fluctuated in the range of 4,000 K to 7,000 K. Correlation between the temperature fluctuation and the uniformity of the produced nanoparticles is under investigation.

4. Conclusion

Nanoparticles of Li_2WO_4 were successfully synthesized by the multiphase AC arc as major product. The obtained finding as well as the visualized temperature field enable to elucidate the nanoparticle formation mechanism.

References

[1] T. Okuma, et al., J. Chem. Eng. Japan, **53**(9), 509-515 (2020).

[2] Y. Zhu, et al., J. Alloys Compd., **811**, 152023 (2019).

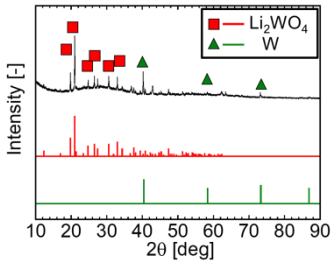

Fig. 1 XRD spectrum chart of produced nanoparticles by the multiphase AC arc at Li:W=2:1.

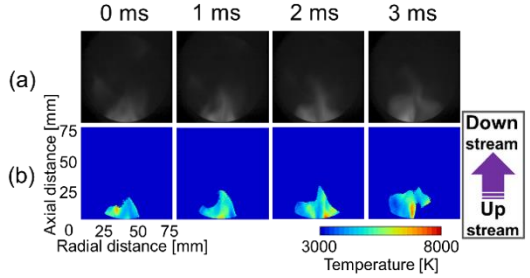

Fig. 2 (a) Representative snapshots of the MPA and (b) corresponding temperature distributions.