Expansion analysis of Si-based anode for high energy lithium ion battery

Yoshihisa Furuya[a], Ikuma Takahashi[a], Shinichi Takahashi[a], Kensuke Yamamoto[a], Tomaru Ogawa[a], and Atsushi Ohma[a]
[a] *Research Division, Nissan Motor. Co., Ltd.*
1-Natsushimacho, Yokosuka, Kanagawa, 237-8523, Japan

E-mail: yoshihisa-furuya@mail.nissan.co.jp

Lithium ion battery has contributed to extension of electric vehicles (EVs) in recent ten years, which will have led to emission free transportation over the world. As it is important for broad range of customers to accept EVs without scarifying convenience of vehicles, higher energy density as well as further cost reduction of lithium ion battery is needed. Si-based anode is one of the promising items for high-capacity and cost-effective lithium ion battery to next generation EVs [1, 2]. However, mechanical and electrochemical instability of the anode which leads to volume expansion of anode, is the bottleneck [3]. The expansion of anode comprises two aspects, (i) mechanical expansion caused by lithiation, (ii) electrochemical expansion caused by accumulation of side reaction products of electrolyte and Li salt on the Si surface. Therefore, fundamental understanding of the expansion phenomena is important to suppress the volume expansion.

In this study, we have defined and investigated binder coverage on Si-based anode materials (active material and conductive material) as a key parameter of the expansion. It was successfully quantified by N_2 adsorption measurement. In addition, we have performed in-situ thickness measurements on pouch cells with different binder coverage on Si-based anode to understand the influence of the binder coverage on the volume expansion. Fig.1 presents binder coverage of anode materials (Si-alloy, graphite, and conductive additives) as a function of binder content. The binder coverage extends with increase of binder contents. Fig.2 presents Si-based anode expansion (thickness) rate as a function of binder coverage on the anode materials. The expansion rate strongly depends on the binder coverage. In the poster presentation, we will also show the detailed data and analysis of the anode volume expansion based on the theoretical calculation.

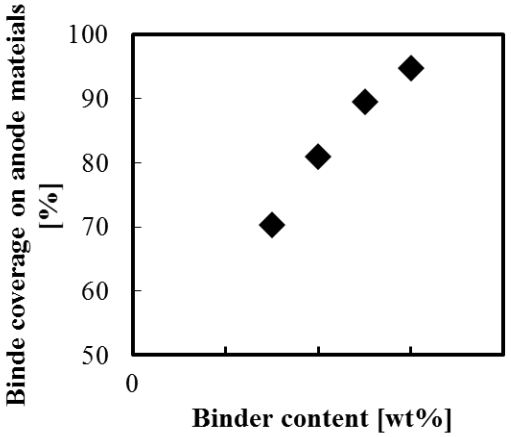

Fig. 1 Binder coverage of anode materials as a function of binder content

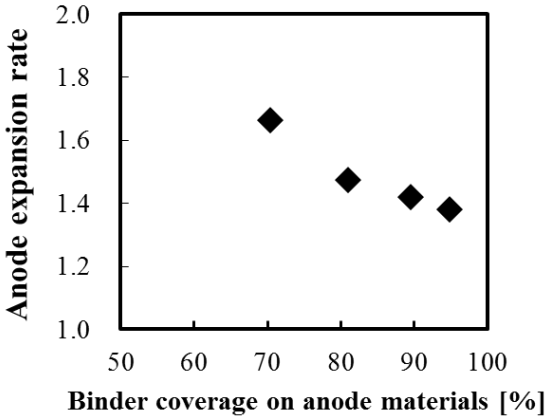

Fig. 2 Si-based anode expansion (thickness) rate as a function of binder coverage of anode materials

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[3] A.J. Louli, J. Li, S. Trussler, C. R. Fell, J.R. Dahn J. Elecchtrochem. Soc. 164 (12) (2017) A2689-A2696