グローバル展開に向けた自動車用鉛蓄電池の開発

Development of Automotive Lead Acid Battery for Global Expansion

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1 Abstract

Eco-friendly automobiles with idling stop system (ISS) are increasingly attracting attention recently and the market of ISS-equipped automobiles is expanding worldwide. ISS-equipped automobile frequently stops and starts engine supplying electric power from the battery to electrical components while the engine is shut off, and enables regenerative charging through alternator during traveling. Therefore, high charge acceptance performance and high durability are required to the battery for ISS-equipped automobiles. Hitachi Chemical (HC) has developed several new technologies for these requirements[1)] and FIAMM Energy Technology S.p.A (FET) has also developed. Both companies became the group company to expand global market share. A battery characterized by the advanced technologies of Enhanced Flooded Battery (EFB), as usually referred a battery for ISS-equipped automobile in European market, was developed by merging specific technologies of HC and FET.

2 Key Features

・By merging technologies of HC and FET, a new EFB was developed, characterized by charge acceptance performances 1.5 times higher than that of European competitor.

3 Development Background

ISS-equipped automobiles are expanding worldwide because ISS can improve fuel efficiency and economy more than the conventional systems with gasoline, by simple redesign of automotive system. Higher charge acceptance performance and higher durability are required to the batteries intended for ISS-equipped automobile in comparison with the conventional one because of the frequent discharging during idling stop and regenerative charging. HC has introduced 1st generation[2)] and 2nd generation[3)] of EFB products into Japanese market and has expanded their sales. On the other hand, HC has made efforts for enhancing product capabilities and expansion of manufacturing locations for the expansion of global market share, and FET became a group company on February 2017. By merging technologies of HC and FET, HC accelerate the development of EFB for the European market. Therefore, we tried to develop this by merging technologies of HC and FET.

4 Technical Content

HC's technology of the additive for Negative Active Material (NAM) and FET's technology of the pasting layer for positive plates were integrated to develop a new generation of EFB characterized by improved charge acceptance and durability performances. Each specific technology is described below.

1. HC's technologies of the additive for NAM

HC has developed the technology of lignin material which has the function to reduce particle size of lead sulfate ($PbSO_4$) generated by discharging. **Figure 1** shows in-situ AFM (Atomic Force Microscope) images related to the changes in NAM morphology during charge-discharge cycles through a comparison between conventional and developed battery. These observations were conducted by potential-step method to analyze transient current response corresponding to electrode potential-step. AFM images after charging show that larger size of $PbSO_4$ crystals still remain in the conventional active material, on the other hand, only Pb crystals were observed in the developed active material. These results imply that miniaturization of active material may make dissolution rate of $PbSO_4$ faster and lead to improve the efficiency of charge reaction.

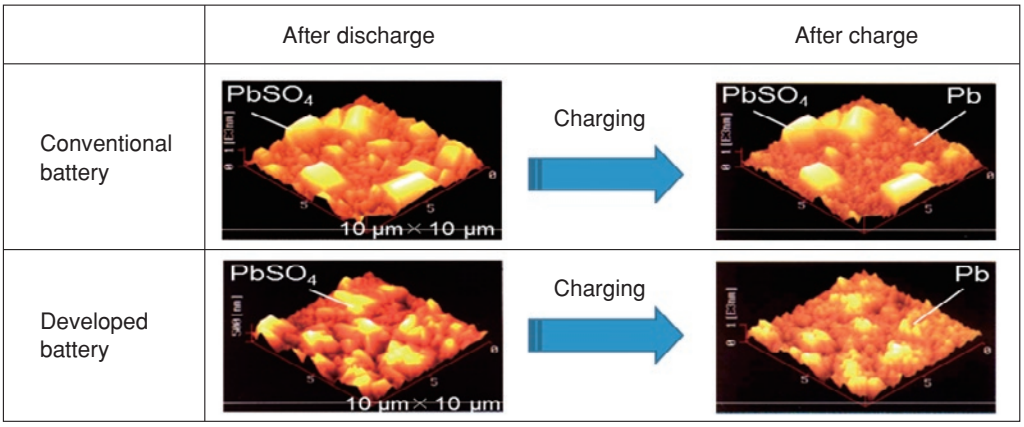

Figure 1 Images of *in-situ* AFM observations which visualize changes in morphology of active materials during charge-discharge cycles

2. FET's technologies of the positive pasting layer

FET developed the technology of pasting layer for positive plates in order to increase durability performances. By analysis and testing of several materials (glass-fiber or totally organic based ones) alternative to the standard pasting paper, FET selected the best one in terms of overall performances and processability. The new pasting layer replaces the standard paper during pasting process and improve the adhesion of the positive active mass, especially during cycling. By using pasting layer, the loss of the active material is significantly reduced and its functionality is maintained. Therefore the durability of the battery, especially at higher Depth of Discharge (DoD) where the functionality of the positive active mass is more stressed, is improved

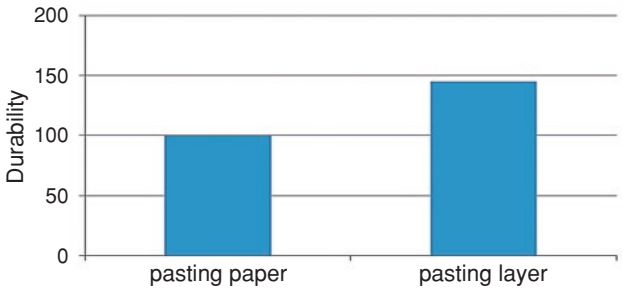

Figure 2 Relative comparison in durability performances between pasting paper and pasting layer on positive plates

3. Performance of Developed Product

Trial products of European Standard (EN) sized EFB including above technologies were manufactured at the plant of FET and some battery performances were evaluated. **Table 1** shows performance comparison between developed product and that of competitor. Developed product has same or higher level of battery performance, like capacity, charge acceptance and cold cranking performance in comparison with that of competitor. Especially, developed product has 1.5 times higher charge acceptance performance. Durability tests are still ongoing, we think that the use of positive pasting layer will improve them.

Table 1 Relative comparison of developed battery performances with competitor's battery performances

Item	Competitor	Developed
Capacity test	100	105
Charge acceptance	100	150
Cold cranking	100	100
Durability*	100	135 (estimated)

*under evaluation

5 Future Business Development

・Sales expansion of developed EFB for European market.

【Reference】

1) Shingo Araki, et al.: Flooded Type ISS Battery with Improved High Durability and High Charge Acceptance, Hitachi Chemical Technical Report, 57, pp.18-19 (2014)
2) Keiichi Wada, et al.: Battery for ISS (Idling-Stop System) Vehicle, Shin-Kobe Technical Report, No.20, pp.17-21 (2010)
3) Koji Otsu, et al.: ISS Lead-Acid Battery 'M-42' for Light Cars, Shin-Kobe Technical Report, No.22, pp.15-18 (2012)

【Reference Patents】

Patent Number 4396527, Patent Number 5445655