# Novel Natural Binder for Ferric Fluoride-based Conversion Cathode

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In this work, we have searched for binder compatible to Iron(III) fluoride ($FeF_3$) that undergoes intercalation and conversion mechanisms. Polyvinylidene difluoride (PVdF) has so far been used as binder for $FeF_3$. However, nano-sizing of $FeF_3$ as well as a large amount of conductive auxiliary compensating $FeF_3$'s poor conductivity requires high dispersion ability of binder in the slurry precursor. Thus, we searched for alternative binder more favorable to such a $FeF_3$ system. We have eventually found a natural polymer (NP) for a nonaqueous binder system; the novel natural binder is soluble in NMP, and the binder was found to provide a uniform electrode film on aluminum-foil current collector in a ratio of 97:3 (w/w) as $FeF_3$ to the binder. Next, we tried to improve the quality of electrode film containing $FeF_3$ to realize charge-discharge operation as well as to get a relatively thick electrode film. We introduced ball-milled $FeF_3$ with acetylene black (AB) to improve the electrode film's quality. [1] The obtained slurry containing the $FeF_3$ particles and our binder with a ratio of 97:3 showed a very high solid component concentration that was more than 50%, although the highest solid component concentration in conventional PVdF-based $FeF_3$ slurry was between 20 and 30%. Such a high solid component concentration should be promising to prepare a high mass-loading or thick electrode. Performance of the present electrode utilizing our NP binder is indicated in Figure 1. The present binder electrode exhibited slightly higher capacity retention compared to the PVdF-based electrode. Furthermore, our binder electrode showed much higher mechanical strength (almost twice) than the PVdF-based electrode when they were tested by an exfoliation strength experiment apparatus (Table 1). These results clearly suggest that the present binder should have resistibility against volumetric change of the active material during cycling.

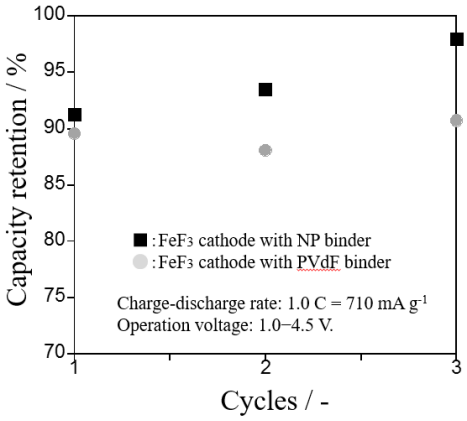


Figure 1 Cycle performances (Charge capacity) of Li-metal half cells composed of FEF3/AB with (■) NP binder, (●) PVdF binder.

Table 1 Peel adhesion strength (between electrode film and Al foil)

| | | Electrode composition | |
|---|---|---|---|
| | Peel strength | $FEF_3$/AB | binder |
| PVdF cathode | 4.39 N/15mm | 95 wt.% | 5 wt.% |
| NP cathode | 7.89 N/15mm | 97 wt.% | 3 wt.% |

**References:**
[1] K. Kumagae, K. Okazaki, K. Matsui, H. Horino, T. Hirai, J. Yamaki, Z. Ogumi, J. Electrochem. Soc., 163 (2016) A1633–A1636.

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