ENHANCED HIGH-RATE CAPACITIES WITH EXILVA

Technical Questions

Can Exilva be used as a replacement binder for carboxymethyl cellulose (CMC) in aqueous anode preparation?

Application & Background

Exilva is a bio-based binder designed to increase high-rate capacities for aqueous-based anode formulations by enhancing slurry rheology and improving electrode cracking resistance.

Case Study & Technical Explanation

A series of graphite-based anode slurries were prepared with increasing substitution of the CMC binder where the CMC was replaced with 10%, 25%, and 50% of 2 wt% Exilva. The slurry, cast electrode, and electrochemical properties were compared with the control (0% Exilva). For the complete list of materials, slurry formulation, and mixing method, please refer to the *Experimental Procedure*.

Increasing substitution of the CMC binder with Exilva results in reduced slurry viscosities at all shear rates (Figure 1). This not only creates the opportunity for increased slurry solids, but also reduces the stress required to pump slurries from storage tanks to the slot die coater nozzles.

The cast electrodes' resistance to cracking was characterized by a mechanical bending test. The images in Figure 2 illustrate that increasing replacement of the CMC binder with Exilva improves cracking resistance.

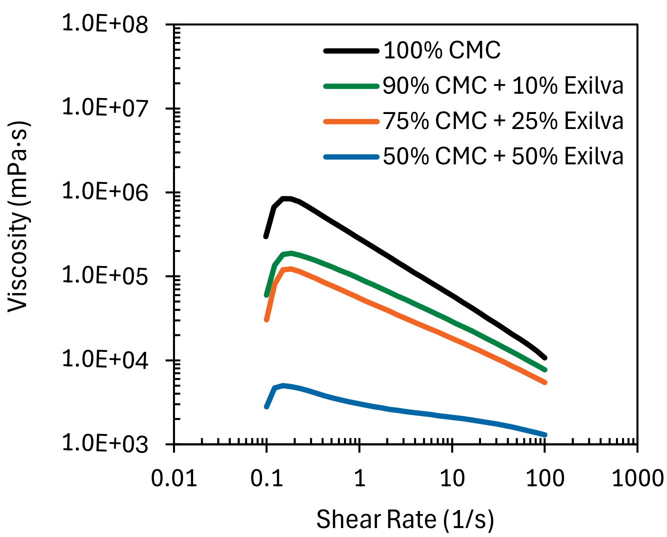

Figure 1. Viscosity curves of slurries emphasizing the reduction in viscosity achieved by increasing the percent of CMC binder substitution with Exilva.

Borregaard

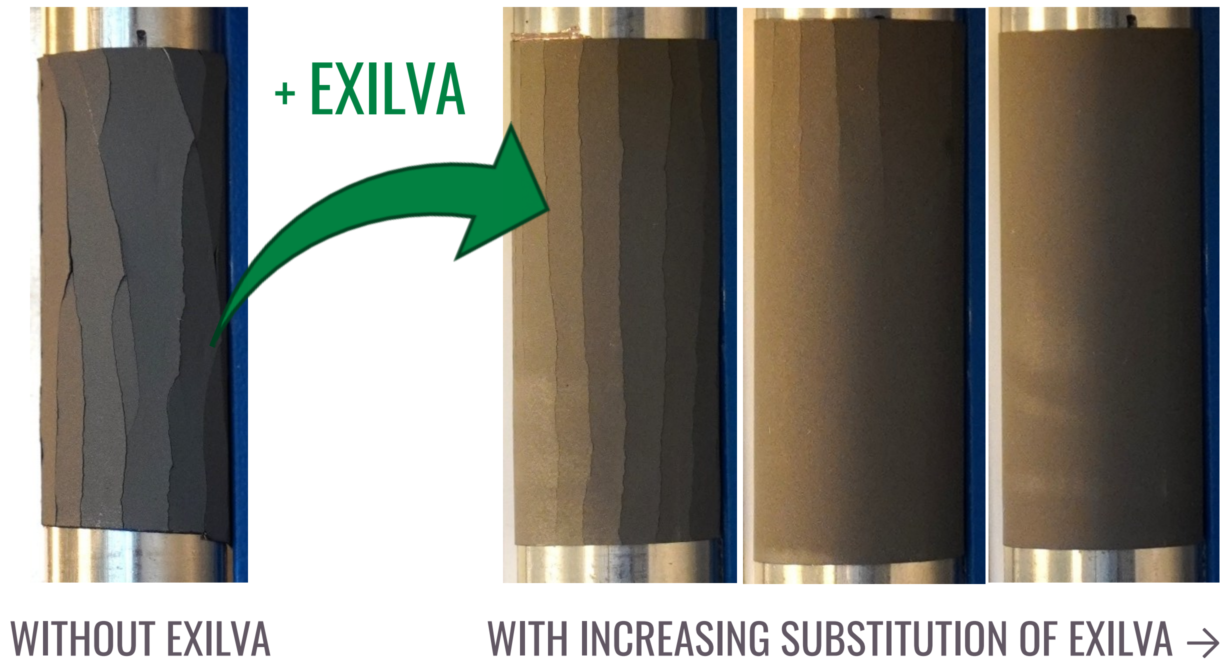

Figure 2. Images of electrodes during the mechanical bending test. Increasing the substitution of CMC with Exilva results in reduced electrode brittleness and improved cracking resistance.

Coin cells constructed with the Exilva-substituted electrodes were cycled five times at seven different C-rates from C_{20} to 3C. The cycling results in Figure 3 demonstrate the improved capacities at all C-rates. The substitution of CMC with Exilva both increased the initial coulombic efficiencies (ICE) relative to the control formulation and improved the cycling stability of the cells at the high C-rates.

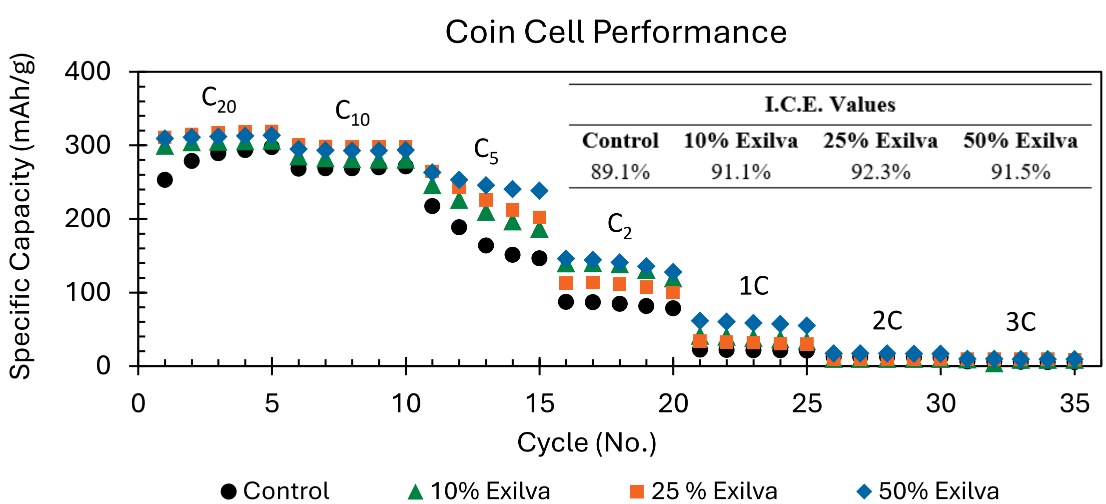

Figure 3. Cycling performance of 2032 half-cells at C-rates of C_{20}, C_{10}, and C_5. Substituting 50% of the CMC binder with Exilva results in increased and more stable capacities at higher cycling rates.

Practical Recommendations & Limitations

Due to the large variation in materials and formulation ratios, a small dosage study is recommended to optimize slurry solution and cast electrode properties. Large substitutions of CMC with Exilva in formulas with small amounts of CMC (≤ 1.5 wt%) may result in viscosity increases. Details of the slurry formulation and mixing method used in this case study can be found in the *Experimental Procedure* section.

Conclusions

Replacing up to 50 wt% of the CMC binder with Exilva resulted in slurries with reduced viscosities, electrodes with improved resistance to cracking, and coin cells with increased high-rate capacities.

Experimental Procedure

Electrode slurries were prepared at a ~ 20 g scale using a THINKY mixer with 2 x 10 mm diameter 314 SS milling media. The THINKY method for preparing slurries can be found in Scheme 1 and the materials used can be found in Table 1. Slurry solids measured to be ~55% with a moisture balance before casting on 10 µm thick untooled Cu foil at 150 µm using a thin film coater/ Doctor Blade.

Scheme 1. Borregaard's THINKY method for preparing aqueous-based graphite slurries.

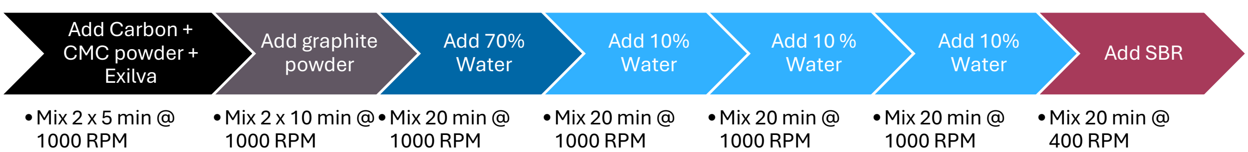

Table 1. List of materials in electrode slurry preparation.

Chemical	Description	Composition
Graphite	High Energy Density graphite from *MSE*	92%
Carbon	Super C45 carbon black	3%
Binder	CMC: (700 kDa) Battery Grade (100% - 50% dose) Exilva 2% (0% - 50% dose)	3%
SBR	Li battery grade SBR from *MSE*	2%