

Recycling of graphitic bipolar plates for vanadium redox flow batteries

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Motivation

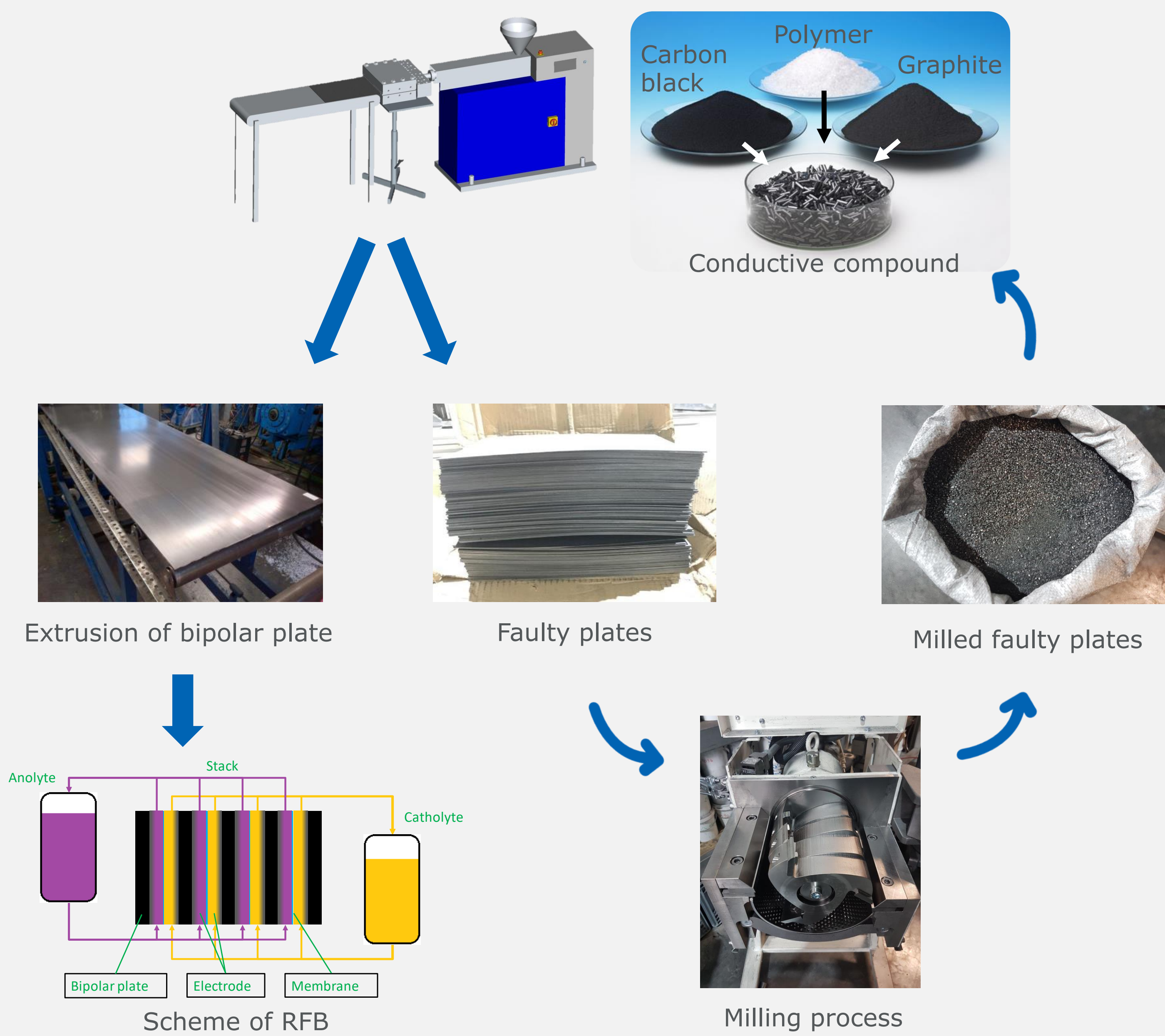
The “Re³dOx” project focuses on **Recycling** and **Resource** efficiency of **Redox-flow-batteries** (RFB). Focus of the work packages at ZBT is to reuse the rejects of the bipolar plate production process. For instance, the faulty bipolar plates within the production are to be shredded and added to the extrusion process again.

A second goal is to use natural graphites instead of synthetic graphites as conductive filler in the bipolar plates and examine their suitability in redox flow batteries to realize a better “carbon footprint” of the product bipolar plate.

Since for some RFB stack designs bipolar plates with flow field structure are needed, ZBT will develop a process to bring in a straight flow field directly during the extrusion process of bipolar plate, instead of milling the functional structures into the plates afterwards.

Content

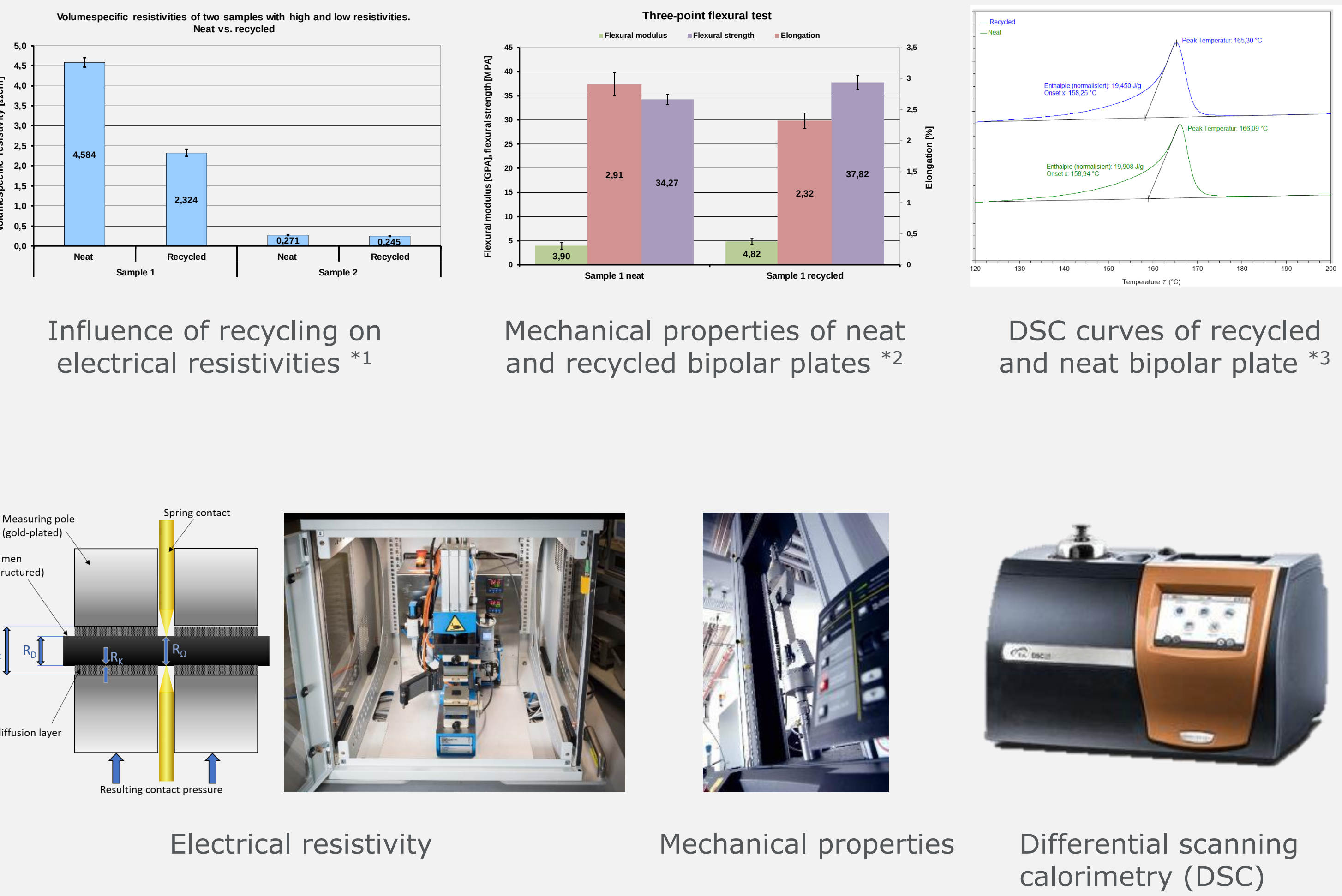
During the production process of extruded bipolar plates, certain amounts of defect plates are produced, which are disposed of in the usual way. It is to be investigated to which amount the faulty plates can be recycled and returned to the manufacturing process. The plates produced from the recycle are tested with regard to electrical resistance, crystallinity of the polymer and mechanical properties. In a later stadium of the project the recycled bipolar plates will be tested in a vanadium redox flow battery for their performance.



Consortium



Ex-situ characterization



Production of structured bipolar plates within the extrusion process

Instead of milling the flow fields into the bipolar plates, a shaping extrusion tool with a straight flow field is designed to produce structured bipolar plates within the extrusion process. Extrusion of different flow field geometries will be tested by interchangeable extrusion tool with variation of channel and web of bipolar plate.

3D CAD model of extrusion tool and simulation of deformation at 250 bar melting pressure

Summary

- Milling of faulty plates and re-extrusion of the milled compound leads to lower electrical resistivities of recycled bipolar plates. For materials with high resistivity the reduction is ~ 50 %, for materials with low resistivities the reduction is ~ 10 %.
- Elongation decreases while flexural strength increases.
- As DSC curves show, melting enthalpy stays the same for neat and recycled bipolar plates. This means:
 - Polymer is not affected by recycling.
 - Differences in electrical resistivity and mechanical properties are due to changes in filler material.
- Purified natural graphite behaves similarly to synthetic graphite in terms of electrical and mechanical properties.
- Overall recycling of faulty bipolar plates maintains performance of neat RFB bipolar plates while drastically reducing waste within the production process.
- Extrusion of bipolar plates with flow field will reduce waste caused by milling and manufacturing cost.

Footnotes:

1: Measured with the BePPel test rig at ZBT 2: Three-point bending test by Instron 5565 3: DSC25 by TA Instruments

Acknowledgements:

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