SUCCESS STORY

BattLab
High performance battery systems driven by polymer science and virtual material engineering

Programme: COMET – Competence Centers for Excellent Technologies

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Type of project: Project 1 - Design of a thermo-responsive coating which assist the early detection of overheating events in batteries, 01/2024 – 12/2027, multi-firm

DESIGN OF SMART AND SUSTAINABLE COATINGS FOR SAFE BATTERY SYSTEMS

RECYCLABLE AND REPROCESSABLE COATINGS ENABLE THE EARLY DETECTION OF CRITICAL BATTERY TEMPERATURES THROUGH THE RELEASE OF TRACER GAS

Batteries system safety in e-mobility has become an increasingly important focus of ongoing research due to the significant number of accidents caused by battery malfunctions. Events such as overcharging, mechanical damage, short circuits, or external heating can eventually lead to uncontrollable heating events in battery cells which in turn can cause fires or, in worst cases, explosions in electric vehicles.

While recent studies have focused on preventive safety techniques, like exploring several fire-resistant materials or cooling devices, our work has taken a complementary approach by a thermo-responsive polymer coating that releases a tracer gas at a very well-defined temperature to enable early detection of critical temperatures in batteries (Figure 1).

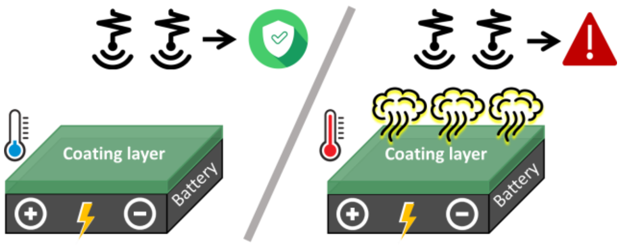

Figure 1: Scheme of gas-releasing event and sensor working mechanism in thermo-responsive coatings

Developing the thermo-responsive coating

A polyurethane-based coating containing a tracer gas was developed. Under defined conditions, these detectable gas molecules are released making this material suitable for safety applications. To confirm the gas-releasing behavior, different thermal characterization tests were conducted. A weight loss associated to the gas release event was observed in the temperature range between 80°C to 180°C (Figure 2). This was further confirmed by additional techniques where the chemical structure of the trace gas was analyzed. To ensure that the tracer gas could be easily detected by metal oxide (MOx) sensors, a test setup close to a real case application was used. The test results were consistent with the findings from the previous characterization tests.

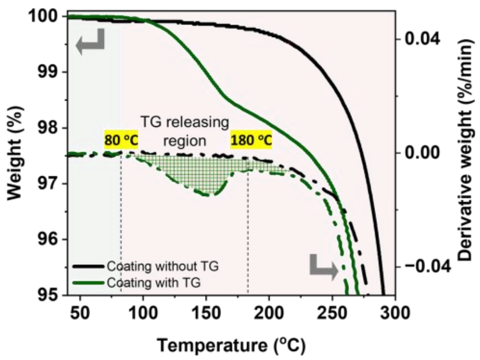

Figure 2: Thermogravimetric analysis (TGA) curves of the coating showing the weight loss due to gas release

In order to minimize the environmental impact, the reusability of the coating was assessed. After the gas release event, the tracer gas can be reintroduced to the polymer coating, so that the coating can function as a safety measure over several life cycles. Alternatively, once the tracer gas has been released, the polymer coating can be remolded, repairing any defects, and reused as an elastic polymer in various desired shapes and forms. This is possible due to the specific properties of the original polymer coating.

Impact and effects

The coating is developed to be a critical component in different battery systems, serving as an efficient precautionary tool to detect dangerous overheating events. By enabling early detection of potential issues, it helps to protect users from the risks of thermal runaway and explosive failures, ensuring enhanced safety and reliability in battery-powered devices. In addition, its recyclability and reprocessability contribute to improved sustainability to lessen its impact on the environment.

Project coordination
M. Sc. Daniel Bautista-Anguís / DI Dr. Johannes Macher
Project Manager / Module Manager
Polymer Competence Center Leoben GmbH
T +43 (0) 3842 42962-85 / +43 (0) 3842 42962-728
daniel.bautista@pccl.at / johannes.macher@pccl.at

BattLab
Polymer Competence Center Leoben GmbH
Sauraugasse 1, 8700 Leoben
T +43 (0) 3842 429262-0
office@pccl.at
www.pccl.at

Project partners

- Montanuniversität Leoben, Austria
- Virtual Vehicle Research GmbH, Austria
- Isovolta AG, Austria
- hofer powertrain GmbH, Austria

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