Battery manufacturing digital twin design in view of requirements for the digital product passport

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This contribution argues that the DigiPass CSA community should establish a subcommunity on digital product passports for battery materials and systems in collaboration with projects from the Battery2030+ CSA3 community, including BatCAT.

BatCAT is the project that will realize the BATTERY 2030+ manufacturability six-year programme within 42 months, addressing battery cell manufacturing innovation for Li-ion and Na-ion cells as well as redox-flow batteries, with a focus on vanadium-based technology. To achieve ambitious cost and performance targets, products and processes need to be optimized for energy density, longevity, and sustainability of batteries, leveraging the combined power of physics-based and data-driven modelling: “Fully digital manufacturing analogues will allow the understanding and optimization of process parameters and of their impact on the intermediate and final product. These virtual representations can be used to manipulate and therefore actuate in the physical world supporting [...] battery manufacturing facilities”[Amici 2022] BatCAT will develop such an integrated virtual development and optimization environment.

Redox-flow batteries are promising for energy storage in renewable energy and will help increase the buffer for temporal fluctuations in energy supply and demand. Lithium-ion battieres are ubiquitous and can contribute to the twin transition as a bridge technology, provided that a rigorous lifecycle analysis is done, based on knowledge integration, to balance beneficial and adverse effects.[Sadik 2023] Work on digital product passports has gained momentum in the context of the circular economy. At present, however, digital product passports are still an emerging field, without a universally agreed-upon standard. Developing a digital product passport system for batteries presents challenges and gaps in the current scientific and industrial landscapes. As the battery industry increasingly adopts digital product passport systems to manage the lifecycle of batteries and promote circular economy practices, it becomes imperative to address these gaps.

The current state of the art in industry is that repair and maintenance is often documented on paper, and companies lack knowledge of the origin and composition of their products. Digital twin technology permits advancing beyond this state of the art substantially, and in many ways. It is therefore a core aspect to developing the digital product passport for battery materials and systems.

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