Supercabatteries as a step forward for micro-mobility power units

Author: Maurizio LASCHI

Department of Industrial Engineering

Laboratory: Experimental mechanics

UNIVERSITÀ DEGLI STUDI FIRENZE

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LIFE2M Long Life to Micromobility

Abstract

Urban mobility has undergone radical changes in the last decade due to the need to solve problems such as traffic congestion or the high levels of air pollution caused by combustion engine vehicles. The most promising solution is to promote sustainable micro-mobility that limits the use of private cars, especially for short journeys. At present, the batteries in these vehicles are mainly lithium-ion cells, with significant trade-offs in the lifetime of the vehicle itself. We have identified a special type of supercapacitor, called a supercabattery, which could represent a significant technological shift, with a lifespan up to 20 times longer than current lithium-ion cells. Our aim is to test them to overcome the problem of such an immature technology for optimal use in micro mobility vehicles.

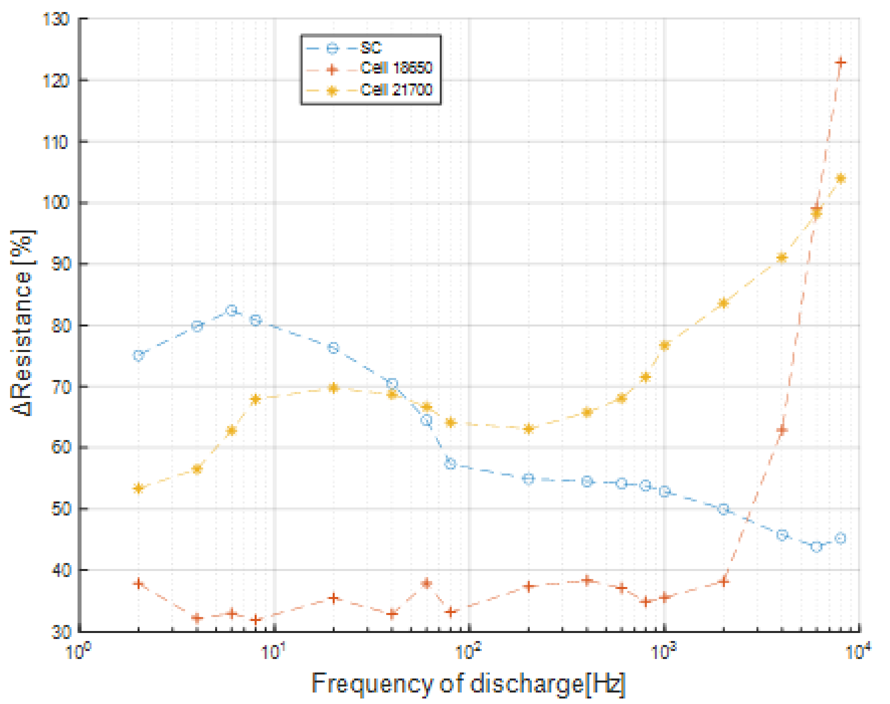

Figure 1. Comparison of change in internal electrical resistence after 20 hours of mechanical vibration, between *supercabattery* and Li-ion cells

The problems of urban mobility

In major European cities, private urban mobility has undergone a revolution in the last decade: the use of a car for all kinds of trips, even those under 5 kilometres, and mostly alone, is completely unsustainable. This has a major impact on the quality of life, both in terms of excessive air and noise pollution, excessive travel time and the lack of versatility of such vehicles in cities where ZTL and other traffic-restricted areas are constantly increasing. This does not mean that the private car should be demonized in favour of public transport for personal journeys, as this would be a severe restriction of personal freedom, but that efforts should be made to encourage the use of less polluting and more sustainable means of transport. The transition to all-electric vehicles, which the European Union wants to see by 2035, certainly helps, but it only solves some problems such as lower environmental impact than combustion engine vehicles; other problems will remain, such as high levels of congestion in urban centres, and others will arise, for example, related to the inadequacy of the current electricity grid or dependence on raw materials. It is crucial to emphasise that all this does not solve the paradox of the car: to move one person and/or a small load requires at least 1200 kg of vehicle and 0.15-0.5 kWh/km of energy. One of the most effective solutions is trying to promote personal micro-mobility as much as possible, by spreading a whole range of light electric vehicles, both private and shared, also suitable for transporting small loads, such as cargo bikes or quadricycles.

Accumutars in the microvehicles

A first attempt was made to promote them in 2020, but the lack of regulations to ensure good construction overshadowed this category. Problems with the quality of the chassis and the fast ageing batteries soon became apparent. The issues with accumulators, made up almost entirely of lithium-ion batteries, typically have a limited lifespan of around 1 to 3 years: subjecting them to severe thermal and mechanical stress, as well as deep charging and discharging cycles would result in a reduction of typical useful life.

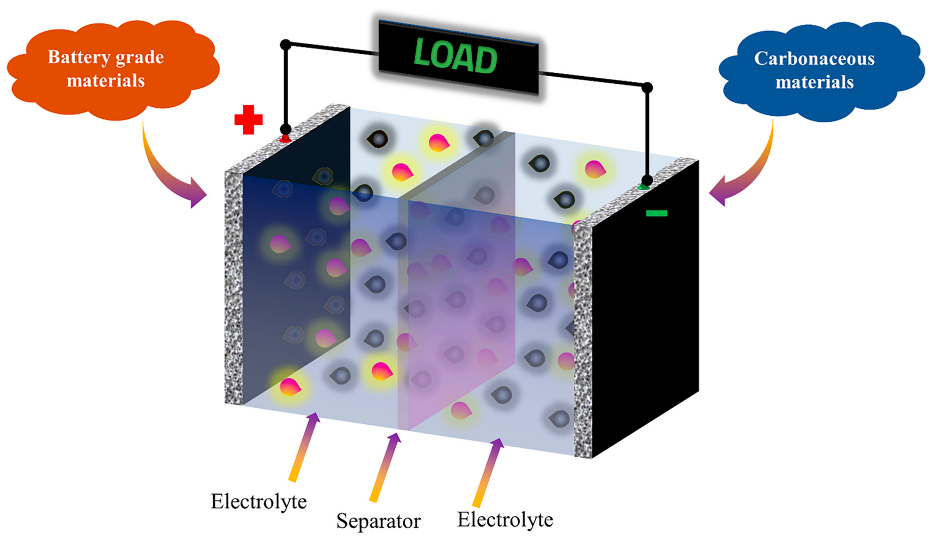

Figure 2. A typical *supercabattery* design. In this case, the anode is made of activated carbon instead of graphite

The *supercabatteries* as a great advance in technology

Our research aims to promote the use of micro-mobility vehicles equipped with hybrid supercapacitor accumulators, in our case also called *supercabatteries (Fig.2)* due to their characteristics. This name comes from the combination of the first part of "supercapacitor" and "battery", since an electrode between the anode and cathode adopts charge storage mechanisms similar to those of batteries. The main feature that distinguishes them from ordinary batteries is that they have a charge/ discharge cycle life that is up to 20 times longer. In addition, they can operate at temperatures as low as -40°C and have no problems with thermal runaway. This type of hybridisation makes it possible to have single-cell operating voltages that are almost identical to those of their battery counterparts, thus allowing retrofitting operations without going so far as to disrupt the control structure of the battery. This change in technology has important implications for the sustainability of the battery and the vehicle, particularly in terms of recycling, repairability and mitigating all the problems associated with the end of life of the vehicle.

Preliminary results

We mainly tested 4000F cells because they are the most versatile for use in micro-mobility vehicles. Charging tests, as seen on Figure 3, were carried out at low temperatures because lithium-ion batteries have the problem of anodic deposition, which often has harmful consequences. The results obtained show both improved behaviour in terms of recharging times and the complete absence of any foreshadowing of possible anodic plating. Mechanical vibration resistance was also tested, with a vibration cycle carried out directly on the vehicle; here too, better resistance is shown, especially when discharged with high-frequency ripple currents, typical of micro-vehicle controllers.

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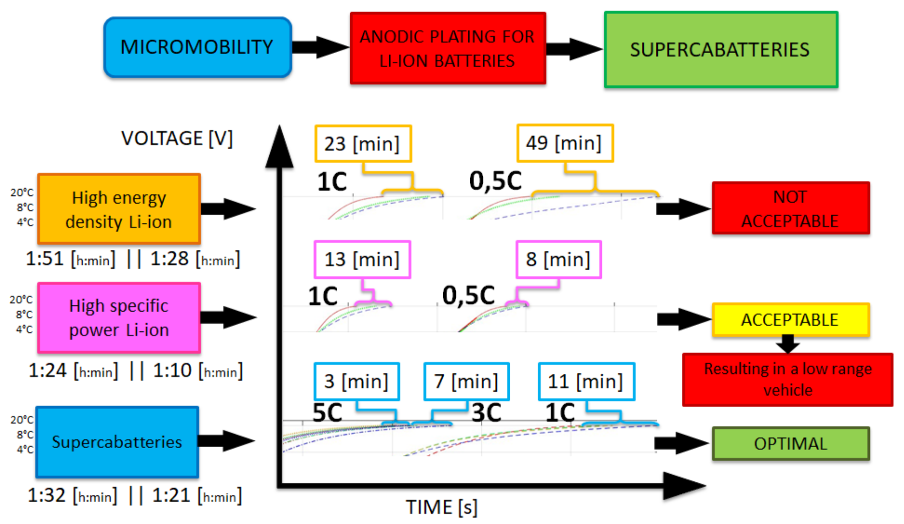

Times for a complete charge at 1C at different temperature

Figure 3. Comparison of recharge time between *supercabattery* and Li-ion cells, charghed at different temperatures (20, 8, 4°C)