

Introducing the nanoFLOWCELL®

Vaduz, 4 March 2014 – Thanks to its nanoFLOWCELL®, a revolutionary further development of flow cell technology, nanoFLOWCELL AG will make it possible for the first time in history to power an automobile with flow cell battery systems. This especially compact and powerful flow cell battery delivers a driving range of up to 600 km in the QUANT e-Sportlimousine prototype.

The novel system developed by nanoFLOWCELL AG is the product of intense further development of the flow cell principle, pushing it to new levels of power density, far greater than those of conventional redox flow-cells. Great advantages in the storage and release of electrical charge result from its more than 5-times greater power density. The Chief Technical Officer of nanoFLOWCELL AG, Nunzio La Vecchia, is convinced, “that the changeover to electric automobiles can happen in the near future; much faster than experts have predicted thus far.”

What is a flow cell?

Redox flow batteries were patented in 1976 for NASA and the American space programme as part of a drive to advance energy storage technology for space flight. The 1976 patents have long since expired and are used by many others today. The flow-cell battery is a beacon of hope because it is an especially simple and effective storage medium for electrical energy. Flow cell installations are already in use as storage systems for domestic solar and wind power plants. They help capture the energy when it is generated and save it for use when it is needed.

Flow cells or flow batteries are a very modern form of energy storage device. Flow cells are chemical batteries, combining aspects of an electrochemical accumulator cell with those of a fuel cell. In the compact cell, a “cold burning” takes place, during which oxidation and reduction processes happen in parallel. The electrolytic fluids in flow cells – usually metallic salts in aqueous solution – are pumped from tanks through the cell. This forms a kind of battery cell with a cross-flow of electrolyte liquid. One advantage of this system in general is that the larger the storage tanks for the electrolyte fluid are, the greater the energy capacity. Simultaneously, the concentration of an electrolytic solution determines the quantity of energy that it transports. The nanoFLOWCELL® system with its very high energy density is opening new horizons in this area.

The energy transfer within a flow cell is roughly the same as that in a good old-fashioned lead-acid car battery: charge passes between metal plates acting as positively and negatively charged poles via an ionisable liquid. One disadvantage of lead-acid batteries is that at 30 Wh/kg, they are relatively weak charge carriers; lead-acid batteries of a useful capacity are by nature rather heavy. Furthermore, due to the so-called “memory effect”, they rapidly lose charging capacity after 500 charging cycles. State-of-the-art lithium-ion batteries have a 4-times greater charging capacity at 120 Wh/kg and retain it for roughly 1.000 charging cycles and can be considered an acceptable temporary solution. Today’s flow cells already have around the same power-density, but are much more durable; they do not suffer from the memory effect.

What is the nanoFLOWCELL®?

The nanoFLOWCELL® is an especially powerful and compact flow cell battery. Its excellent scalability, simple construction, and easy operation give it decisive advantages for use in the construction of electric automobiles.

To charge or discharge the nanoFLOWCELL®, two different electrolytic solutions are pumped through the appropriate battery cell in which an electrode (anode or cathode) is located. A membrane that is a bit like very sturdy household cling film separates the two electrolyte chambers and their differing chemistries. No mixing occurs between the high-charge ion carrier and the low-charge one; this would be useless for producing electrical power.

Advantages of the nanoFLOWCELL®

The very newest product moving the world towards attractive electric mobility, the nanoFLOWCELL®, was conceived and is being developed at the simulation lab of the nanoFLOWCELL AG, the nanoFLOWCELL DigiLab in Zurich, Switzerland. The results are very promising: At a nominal voltage of 600 V and 50 A nominal current, the system is achieving an impressive continuous output of 30 kW.

In terms of energy storage capacity and density, the nanoFLOWCELL® can already store 20 times more energy than the conventional lead-acid battery. This means driving 20-times further with the stored energy in a battery of the same weight. It has a 5-times greater capacity (and therefore potential driving range) than current lithium-ion technology, with which many current electric cars are powered. For some perspective, one litre of petrol contains 11,400 Wh, or 400 times as much energy as a lead-acid battery.

Comparison of current energy storage systems			
Designation/Unit	specific power W/kg	specific energy Wh/kg	Factor kW/kg compared to lead acid battery
Lead-acid	100	30	1
Li-Ion	300-4.000	120	4
Flow cell, Redox	10	120	4
nanoFLOWCELL®	6.000	600	20
Petrol, Diesel	depends on engine	11,800	400

The reason that the nanoFLOWCELL® performs so well lies in the characteristics of its newly-developed electrolytic fluids, made up of exacting combinations of specific metallic salts at very high concentration. The charge-carriers within the carrier liquid have been taken to a new level of charge density through the use of quantum-chemical nano-mechanisms and therefore carry more energy than anything previously seen. A welcome

side effect is that the charging flow within the cell is almost entirely loss-free. The internal efficiency of the nanoFLOWCELL® is more than 80%.

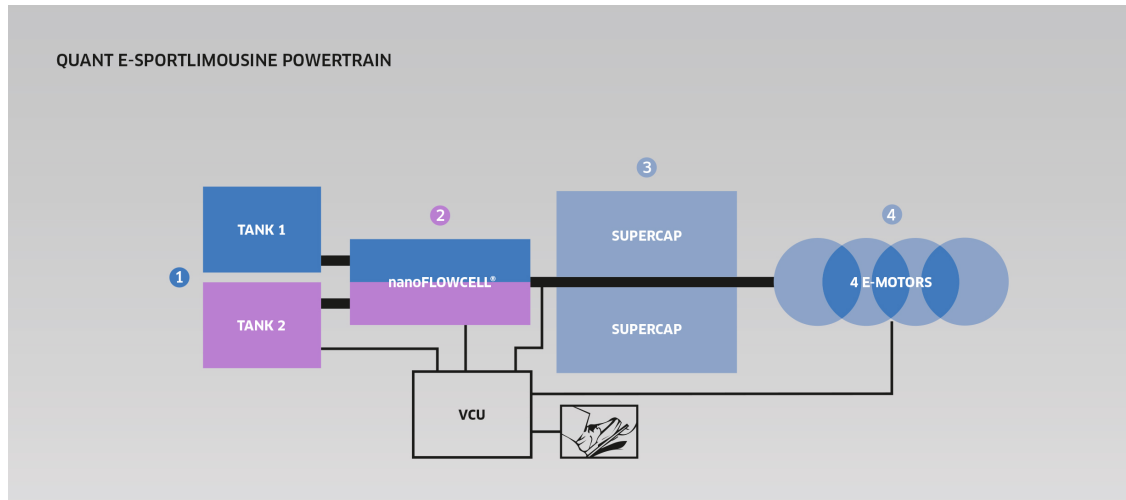
The current energy density of 600 Wh/l is already an impressive five to six times greater than lithium-ion batteries. In addition, flow cells can go through 10,000 charging cycles with no noticeable memory effect and suffer almost no self-discharging. All of this predestines this technology for a great part in the development of electric mobility concepts.

Another advantage comes through the simple scalability of the nanoFLOWCELL® storage tanks. The first QUANT e-Sportlimousine prototype carries two 200-litre tanks on board. Its energy load is therefore 200 times 600 Wh/l: 120 kWh in total. The QUANT e-Sportlimousine uses its energy reserves frugally, consuming about 20 kWh/100 km. Just like conventional cars, an electric car's range depends on its total storage capacity and its consumption. In the case of the QUANT e-Sportlimousine, the average is around 600 kilometres.

The consumption figure of roughly 20 kWh/100 km is a standard value, representing driving in the lower load range, using the consumption cycles as calculated for all vehicles. Further improvements are possible. Increasing the tank volume of the QUANT e-Sportlimousine to 800 litres would be relatively simple. It is much easier for manufacturers to integrate more tank volume into modern vehicle bodies than it is to add or expand heavy battery systems with complex series connections, conduits, and separate cable harnesses for the precise monitoring of all individual battery cells.

The QUANT e-Sportlimousine powertrain

Four electric motor units make up the QUANT e-Sportlimousine's propulsion concept. Alongside the tanks, there is the nanoFLOWCELL®, which continuously sends electrical energy to the central storage unit. This energy storage unit is made up of two large high-performance capacitors, built to the specifications of current "supercap" capacitors. These capacitors are lossless electrical energy storage devices that can release energy very rapidly; an important criterion for a sports car's driving performance. In addition, there is a state-of-the-art central VCU (vehicle control unit) responsible for controlling the driving- and charging-currents throughout the entire powertrain.



State-of-the-art supercaps are the storage units that provide power to the four drive motors when the driver pushes down the “gas pedal”. The supercaps are also a general energy buffer for the vehicle’s electrical system. During braking or rolling downhill, the drive motors’ polarity is reversed, turning them into generators that also provide electricity to be stored in the supercaps and re-released when needed.

Refuelling is simple

The nanoFLOWCELL® functions as a tireless source of energy for the central storage unit as long as sufficient electrolytic fluid is present in the tanks. Once the reserve is used up, the contents of both tanks must to be replaced. This process is no more complicated than filling up a conventionally powered vehicle today. The prototype features a double tank system with dual filler necks, one for each electrolyte, to keep times for the electrolyte liquid replacement to a minimum.

The major difference from all other electrical energy storage systems is the range that a filled nanoFLOWCELL® tank offers: A reasonable tank volume of 200 to 400 litres can provide a 600 km radius of action, a distance comparable to today’s combustion-engine-powered vehicles.

Extremely Environmentally Friendly

The nanoFLOWCELL® generally utilises components that are not only harmless, but which are also easily available in large quantities. Precious metals and rare earths are not used in the system. The principal components of the cell are the water in the carrier solution, metal salts, and crystalline structures that have been combined in environmentally friendly processes and which can be disposed of with no environmental impact.

The current state of knowledge indicates that the nanoFLOWCELL® will cause no environmental complications during operation or disposal. The current state of development indicates that the system could also perform well over an extended service

life: The nanoFLOWCELL® can undergo 100-times more charging cycles than conventional battery systems (lead-acid ca. 500, Li-Ion ca. 1.000). Flow cells do not suffer from the memory effect and their self-discharge is minimal when not in use (less than 1%/day).

A Quantum Leap in Development

Process-Engineers call the chemical activity within the cell “cold burning”, though the internal operating temperatures can range from 60° to 160° Celsius depending on output. This low operating temperature range also contributes to the system’s excellent internal efficiency of more than 80%: No exhaust heat means no losses. Most impressive is the incredible simplicity of the energy conversion within the cell; apart from the electrolyte pumps, there are no moving parts at all.

To achieve this degree of efficiency across the whole system, researchers at nanoFLOWCELL AG have had to create and follow innovative paths, some of them right down to the quantum mechanical level. The nucleus of this progress was born in the nanoFLOWCELL AG simulation lab, the nanoFLOWCELL DigiLab in Zurich.

Years of simulation, tuning, and testing of digital models at the DigiLab laboratory for virtual research and development in Zurich went into finding and mastering the key aspects of quantum chemistry for charge transport before the necessary components could be synthesised for the laboratory and real-world testing. Creating an electrolyte based on “the simulation engineers’ wish list” turns the usual order of things in science and research on its head.

The researchers and technicians involved even speak of a “quantum leap” in this regard. They point out that physical and natural limits for comparable systems previously deemed absolute have largely been broken thanks to the characteristics of the nanostructures developed for the electrolytic charge carriers. The mastermind at nanoFLOWCELL AG, Nunzio La Vecchia, speaks of, “the systematic development of an extremely ionically charged solution, which is the breakthrough to new, high-performance, liquid charge-carriers. It is as though we had captured the explosive power of dynamite as a fuel, stored it in an electrolyte, and made it usable in accurate dosages.”

Nunzio La Vecchio underscores, “The physical and chemical barriers in this area, expressed as the technical limits within the Nernst Equation⁽¹⁾ have been pushed so far back by our research and development work that we have even surprised ourselves. The new quality level of the working mechanisms within the nanoFLOWCELL® represents a decisive step down the path to spirited electrical mobility.”

The Nernst equation describes the limits governing the transport of electrical charge in liquids and also represents a barrier for any scientist working on electrical charge transfer in a chemical cell. Nunzio La Vecchia is certain: “Our system of goal-oriented simulation has allowed us to break through the mass-effect bonds of quantum chemistry. This brings a future of electrical mobility much closer to reality.”

((1) Named after Walter Nernst, 1868-1941, Nobel Prize for Chemistry winner 1920))

Media contact

Press Office nanoFLOWCELL AG
c/o waterworks PR
Volker Pulskamp-Böcking
Mörikestraße 15
DE-70178 Stuttgart
tel.: +49 (0)711/380-303-520
email: presse@nanoflowcell.com
web: <http://www.nanoflowcell.com>

About nanoFLOWCELL AG

Founded in late 2013, nanoFLOWCELL AG is an innovative Research and Development Centre based in Vaduz, Liechtenstein. The focus of nanoFLOWCELL AG's research is on the advanced development of drive technology and the classification of flow-cell technology. In the simulation laboratory of the nanoFLOWCELL DigiLab in Zurich, mastermind and development chief Nunzio La Vecchia and his team examine important aspects of quantum chemistry on the basis of molecular engineering. For years they simulated experiments with charge transfer, then conducted trials using digital models, before finally synthesising them for further testing. The current research vehicle, the QUANT e-Sportlimousine, enables the developers to study the mechanisms of charge transfer for the innovative storage technology – the nanoFLOWCELL® – during vehicle operation, as well as to fine tune charge strategies for recuperation and further develop the regeneration of cell charging and safety as well as quality controls.