VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Néstor Calabia Gascón**

The public defense will take place on **Thursday 26th September 2024 at 5:00 pm** in room **I.0.01** (Building I, VUB Main Campus)

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STUDY OF CONDUCTIVE POLYMER-AL SYSTEMS AND THEIR PROMISING APPLICATION AS ENERGY STORAGE DEVICES FOR HYBRID AND ELECTRIC CARS

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Abstract of the PhD research

The development of energy storage devices is one of the key tools for the reduction of the carbon footprint of the present. Many different devices and systems had their source of energy, often a combustion engine, substituted by a battery. However, batteries, as good as they are storing energy, they lack power and they degrade quickly under electrical stress. As an alternative, in scenarios where power is required capacitors can be applied. These devices store a smaller amount of energy, but they are able to deliver it or receive it at a much faster rate. Ever since the first capacitors, the engineering of their components has transformed these devices into a new level. Nowadays, the new capacitors, also called supercapacitors, are able to store larger amounts of energy retaining good charge/discharge rates.

The evolution from traditional capacitors to supercapacitors was achieved thanks to increasing the surface of the electrodes and the use of a liquid electrolyte that closes the circuit in between. As a result, these systems meet the best of both worlds: high power density as traditional capacitors and higher energy densities. However, the presence of a liquid electrolyte implies a new set of issues to overcome. Using a liquid electrolyte introduces the risk of it freezing or evaporating depending on the temperature of use or even the possibility of leakage, causing the capacitor to stop working. In order to avoid these issues, conducting polymers were applied substituting the liquid electrolyte. Conducting polymers, such as PEDOT:PSS, are suitable candidates since they can be easily applied in between the electrodes, allowing a close contact between them and achieving the optimal performance for that combination. Additionally, they avoid the risk of leakage completely and the temperature limitation. The use of PEDOT:PSS, holding the best properties among conductive polymers for this application, solves these problems, but the interaction of it with a porous aluminium electrode, common in polymer electrolytic capacitors, is not entirely understood.

In this work, a stack of common components in solid polymer electrolytic capacitors, such as aluminium and PEDOT:PSS, was produced and studied. This project evolved from defining the methodology to appropriately analyse the Al/PEDOT:PSS stack and the exploration of the simplest systems, to the study of the electrical properties as samples that resemble real systems. The development of these model systems provides a deeper understanding of the processes that take place in solid polymer electrolytic capacitors and opens new ways to improve the properties of these systems.