ENERGY

Light Metal Alloys

21_ENER_LMF_EDLCcapacitor

Title: EDLC capacitors with anodized aluminum foil

Summary: The basis of this challenge is to create a product, an EDLC capacitor that has an anodized aluminum foil. However, we must not forget that the capacitor is made from several different components and not just an anodized aluminum foil, and all components work together simultaneously to get the best capacitance values. Among these components, we give a high importance to the cohesion between the anodized aluminum foil and electrolyte.

Challenge is to develop EDLC capacitors with anodized aluminum foil. In combination with a suitable electrolyte, it has a higher specific surface area, which in turn allows us to have higher capacitance values. By achieving higher capacitance values with less material we are bringing lightweighting to the field of capacitors as well by reducing the materials and implementing new modern material we are reducing CO_2 emissions as well will develop and implement new production technologies with aiming to reduce CO_2 emissions.

We have chosen the material for the heart of the capacitor - the capacitor roll as aluminum. The metal itself is very reactive and spontaneously forms a thin transparent oxide layer, upon contact with atmospheric conditions, which provides great stability. The oxide layer has the properties of a dielectric, and its surface is porous, which increases its active surface. Therefore, we want to use it as a dielectric, and with its properties significantly increase the capacitance of the capacitor at the same dimensions. It is possible to form an oxide layer to the correct thickness and porosity by various electrochemical processes. This allows us maximum capacity per unit volume. Therefore, in the field of technology, it will be necessary to develop the process of anodizing the aluminum foil to gain the required specific active surface needed.

The electrolyte in an electrolytic capacitor supports the operation of the capacitor. When impregnating the capacitor element - coil, with liquid electrolyte, we electrically connect the cathode and anode material. In the presence of a layer of aluminum oxide formed on the anode foil and acting as a dielectric, a capacitor with a high capacitance value is obtained. In this case, the electrolyte has a cathode function. The basic properties that the electrolyte must meet are electrical and ionic conductivity, chemical stability and compatibility with other capacitor components, superior impregnation characteristics, low viscosity and good surface tension.

Scope:

- In the field of capacitors, we want to increase the capacitance value of the EDLC capacitor by increasing the specific surface area by anodizing the aluminum foil, which is achieved in combination with a specific electrolyte.
- It will be necessary to determine the thickness of the anode layer, porosity and other properties of the material.

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- In the field of technology, it will be necessary to specify the process of anodizing aluminum foil so that it will achieve the required dielectric (aluminum oxide) properties.
- Activities to be carried out will also include research and development of a suitable electrolyte, a fluid with a wide range of electrical properties from ESR (Equivalent Series Resistance), a range of capacities ranging from millifarads onwards, electrolyte leakage, life-enhancing additives, operation and maintenance of primary functions at high temperatures, vibrations, pressures and other severe environmental conditions (humidity,…)
- Missing knowledge is also on the material side when speaking of the electrolyte composition. The technology side mentioned before (anodization process) will be determined in next future steps. – When an ideal solution for the EDLC has been determined, the production technology comes. This means that after the goal has been reached, a production process is to be developed.
- Laboratory equipment is also missing to provide right and fully need to successfully finish the project.
- Missing knowledge and equipment can be provided by Institute – if we do not have the required analytical equipment for certain required analysis, or, if there is a question on which we cannot give the answer to, an external Institute or University can be found as a subcontractor.

Objectives:

- determine the appropriate thickness of the anode layer
- ensure a porosity standard
- development of new technological processes for the production of new capacitors
- achieve other material properties (basic electrolyte properties: electrical and ionic conductivity, chemical stability at temperatures up to 120 °C and compatibility with other capacitor components, does not cause corrosion in other elements, superior impregnation characteristics, low viscosity and good surface tension).

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22_ENER_LMF_contactPADS

Title: Contact pads in low voltage switchgear products

Description: Improving the balance of conductivity in low voltage switchgear products by improving existing or providing alternative materials (metal or ceramics)

We want to improve the materials (currently used are $AgSnO_2$ and AgW) with which we achieve the mechanical properties required in low voltage switchgear, especially by improving the balance of transportability by changing the hardness, strength, resistance of contact surfaces to welding in electric arcs, weight and CO_2 friendliness.

Scope: When we are switching load, contact pads hit with each other and electric arc is created. This electric arc burns out contact pads and lifespan of the switch is shortened.

We want to develop materials that will be more resistant to contacts, while we want to meet the new market requirements for the implementation of new advanced materials and internal and external needs to reduce CO_2 footprint.

The standards IEC/EN 60947-4-1 and IEC 62955 specify:

- short-circuit tests (3000 A with pre-fuse): At short-circuit tests very high temperatures are generated which can melt or evaporate copper and the contact material/pads.
- switch on test at full load (high switching currents, high inrush current): electric arcs are created burning down the contact material.
- allowable heat on the contacts: Contact material such as AgW can have higher contact resistance causing non-conduction through the pole and overheating.
- switches' mechanical durability: 3 million cycles with no load.

Objectives:

- Improving the balance of conductivity – mechanical properties (hardness, strength,
- resistance of contact surfaces to welding in electric arcs and CO_2 emissions)
- Improving technology of production targeting CO_2 footprint reduction
- utilization with standard category AC-1 and category AC-3

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