Advances in Science and Technology of Capacitors

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Capacitor industry has made a remarkable advance with the progress in electronics industry and has a market size as large as that of battery industry. At present, production of capacitors is increasing with the expansion of market in mobile applications such as portable telephones, and audiovisual equipments that necessitate capacitors as parts. Moreover, capacitors with super large capacitance have begun to appear and are expected to substitute a part of secondary batteries.

The miniaturization and high frequency digitalization of electronic equipment are progressing rapidly. The advances in surface mount technology and high density packaging technology realized the miniaturization of personal digital assistants such as database and computerization management and information-communication equipments such as computers, telephones, etc. These technologies require miniature capacitors that can handle high frequency and yet are environmentally safe. Therefore, the following technologies are being developed keeping the characteristics of each capacitor. To enhance capacitance, development of materials having high dielectric constant, thinning of dielectric layer having high breakdown voltage and enlargement of electrode area are being carried out. In electrolytic capacitors, new etching technology of Al foil and Ta powder of high CV product are being developed. In ceramic capacitors, developments of ultra fine particles of high dielectric constant and ultra thin dielectric ceramic layer are being carried out. Recently, palladium electrode powder has been replaced by ultra fine nickel electrode powder for cost reduction of multi-layered ceramic capacitor. Functional polymers such as poly-pyrrole become essential to obtain chip type electrolytic capacitors that are resistant against heat during reflow soldering process and can handle high frequency by lowering the impedance. On the other hand, developments of environmentally friendly materials free of lead, halogen and dioxin are being accelerated. New construction methods are being developed as well as the new materials to miniaturize the capacitors. The examples are chip type Ta capacitors having electrode underneath and array type multi-layered ceramic capacitors.

Electrochemical capacitors composed of electric double layer capacitor and redox capacitor are expected to apply to secondary power sources in HEVs and fuel cell electric vehicles and substitutes of secondary batteries. This is achieved by enhancing energy density, power density and life of electrochemical capacitors. To meet such requirements, for electric double layer capacitors, new activated carbon electrodes and electrolytes of large decomposition voltage are being studied. For redox capacitors, innovative oxide and conductive polymer electrodes are also being studied.

In this way, capacitor extending from electrolytic capacitor and ceramic capacitor to electrochemical capacitor advanced rapidly in science and technology and became one of the key device supporting the electronics, energy and environment, whose importance is expected to boom in this new century. The materials used in capacitors are ranging from inorganic materials to organic materials that have the form of ultra fine particles, thin films and thick films. Besides the material itself, minute and precision processing and multi-layering have become important in preparation process of capacitors. From now on, capacitors that work at low voltage, save energy and have high energy density are expected to appear using the aforementioned technology.

In this century, science and technique of electrochemistry will be applied and will help to create new technology one after another in electronics, energy conversion, environment and biotechnology. Capacitors that are based on electrochemistry are expected to contribute to the creation of comfortable and healthy surroundings of mankind.

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