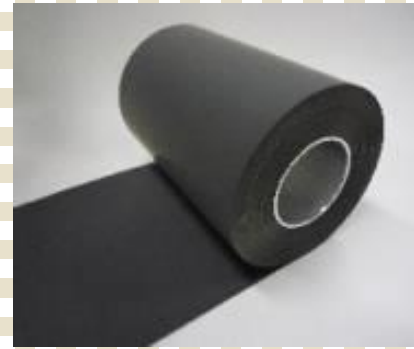


Composite material for electrodes: TOYAL-CARBO®



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“TOYAL-CARBO®” product coil

【 1. Features 】

An aluminium oxide layer exists on the surface of aluminium foil and this oxide increases the electrical resistance in electron transfer. A method to reduce this electrical resistance that has been used widely for many years has been a treatment to coat the surface of the aluminium foil with conductive carbon particles. However, if organic binders are used to fix the carbon particles, then these binders become resistance components and the problem arises that they deteriorate in long-term use and the carbon particles separate from the foil. Toyo Aluminium discovered the unique technology that aluminium carbide is formed when aluminium foil is heated to a high temperature in a hydrocarbon atmosphere. With “TOYAL-CARBO®” (Figure 1), this phenomenon is exploited to fix carbon particles to the surface of aluminium foil without using any organic constituents. The result is extremely good conductivity and durability at high temperatures.

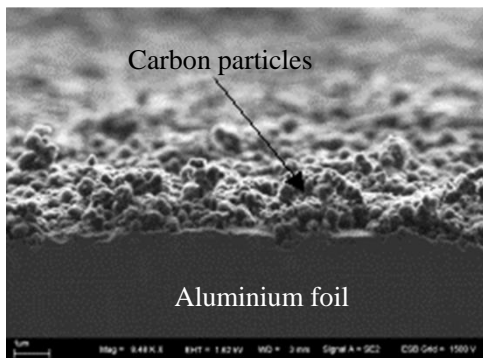


Figure 1 Cross-section SEM image of “TOYAL-CARBO®”

【 2. Manufacturing method 】

This product is available with three different thicknesses of aluminium foil: 20, 30 and 50 μm. Carbon particles are coated onto both sides of the foil, with the coat adjusted to be 1 μm thick on each side. This foil is then kept at a temperature of 873 K or higher in a hydrocarbon atmosphere. This causes Al<sub>4</sub>C<sub>3</sub> to form and the carbon particles become fixed on the aluminium foil (Figures 2, 3).

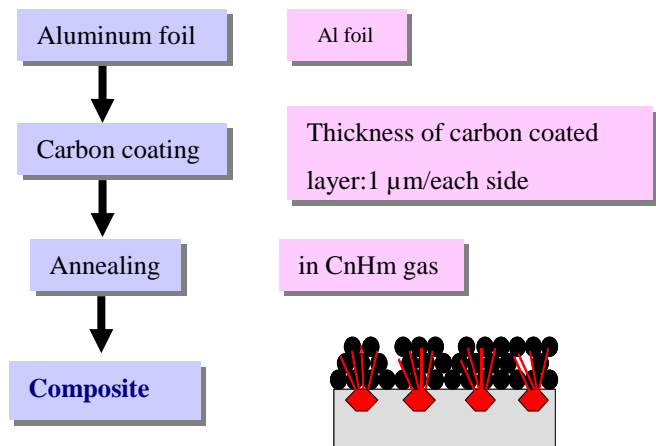


Figure 2 TOYAL-CARBO® manufacturing processes

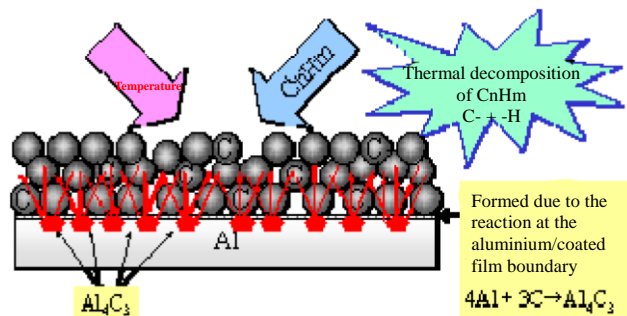
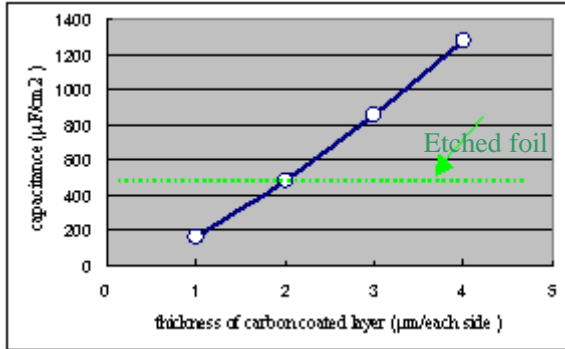


Figure 3 Mechanism of Al<sub>4</sub>C<sub>3</sub> formation

### 【 3. Performance 】

#### (1) Capacitance

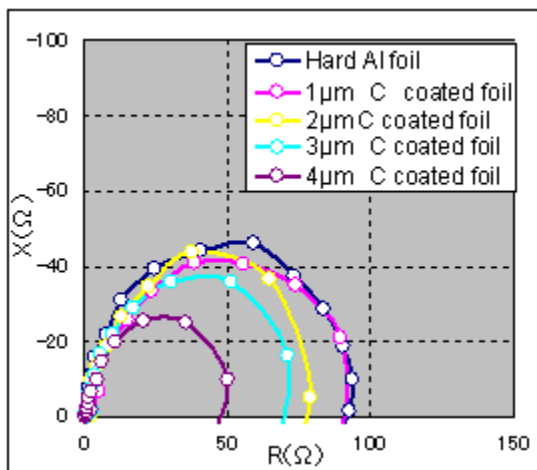
It is possible to control the capacitance by changing the thickness of the layer of fixed carbon particles (Figure 4).



**Figure 4** The relationship between the carbon particle layer thickness and the capacitance value

#### (2) Electrical resistance

When the resistance components of the materials are compared by measuring the AC impedance (Figure 5), it can be seen that the electrical resistance is either equivalent to or lower than that of hard aluminium foil, which has the lowest resistance.



**Figure 5** Results of AC impedance measurements

<Measurement conditions>

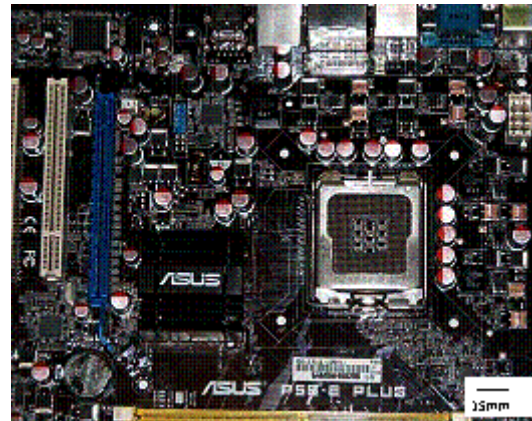
Electrolytic solution: 1 M hydrochloric acid solution

Frequency: 0.5 Hz~1,000 Hz

### 【 4. Applications 】

This is a composite material with both excellent electrical conductivity and stable heat resistance, so the following applications can be considered for it.

- The cathodes of functional solid polymer capacitors. Particularly ideal for products for use on computers, etc., when there is a requirement for low ESR / miniaturization performance (Figure 6).
- Current collectors for electrodes on electric double-layer capacitors.
- Current collectors for cathodes on lithium-ion secondary batteries.



**Figure 6** PC motherboard with all functional solid polymer capacitors using “TOYAL-CARBO®”