Electroconductivity and mechanical properties of film by aqueous carbon black paste.

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Introduction

Not only printing industry and also electronics field expect conductive ink, which made by aqueous solution, VOC free matrix, and much cheaper material. We made pastes with conductive carbon black(CB) and aqueous emulsion polymer. We observed electroconductivity and mechanical properties of films made by aqueous pastes with conductive carbons. In this paper, we discuss these properties and possibility of CB conductive ink with aqueous polymer.

Table 1 Porosity and Crysallite Size of CBs

CBs	Ketchen Black EC	#3230	#3350	#5500
SSA/$m^2 \cdot g^{-1}$	800	220	125	225
Particle Size / nm	52	52	46	61
Lc / nm	1.0	1.2	1.3	1.4
La / nm	2.3	1.5	1.5	1.5

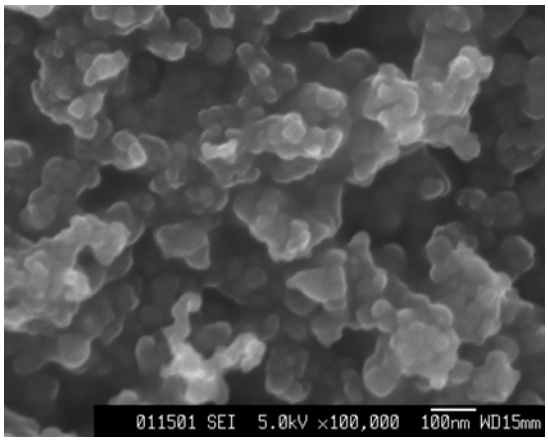

Fig. 1 FE-SEM image of #5500.

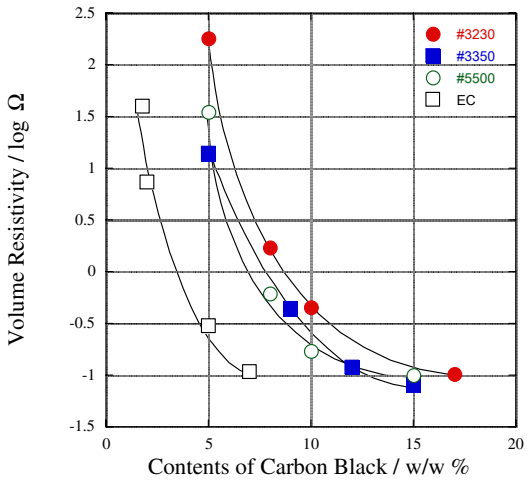

Fig.2 Volume Resistivity of Various Contents of Carbon Black in Paste after heating at 390 K.

Experimental

Four kinds of CB were used in these experiments. These are Ketchen Black EC(EC), #3230, and #3350 supplied from Mitsubishi Chemical and Toka Black #5500 from Tokai Carbon. Aqueous urethane resin (SuperFrex R-5002; Dai-ichi Kogyo Seiyaku) was used as a matrix polymer. We observed particle size from FE-SEM images. (Figure 1) Their surface properties and crystallite size of CBs were shown in Table 1.Film preparation: Each carbon black mixes with the urethane resin using three roll mill for 10 minutes. CB pastes were laid on the PET film using applicator, and at last, films were put on for heat curing with oven at 110˚C for 30 minutes or longer. Electroconductivity were measured by 4 terminal method at temperatures from 30˚C to 125˚C. The stress and strain measurements were carry out at room temperature using RheomerII (Yamaden). Dynamic viscoelastic properties were measured by RDSII(Rheometric) at temperature between room temperature and 150˚C.

Results and Discussion

Electroconductivity of each CBs was shown in Fig. 2. We come about the resistivity of film less than 1 Ω. Paste from EC shows better conductivity than other carbon blacks with less doping amount of carbon itself. It should come from that EC has a hollow structure. Because Young's modulus of a film by Kechen Black is much lager than others with same CB fraction. (Fig. 3) In addition that all carbon films are not hard, and stretchable. There is no temperature dependence of conductivity after heat up to over 100˚C. (Fig.4) This means that conductive process is not semiconductive, but inter-particle directly.

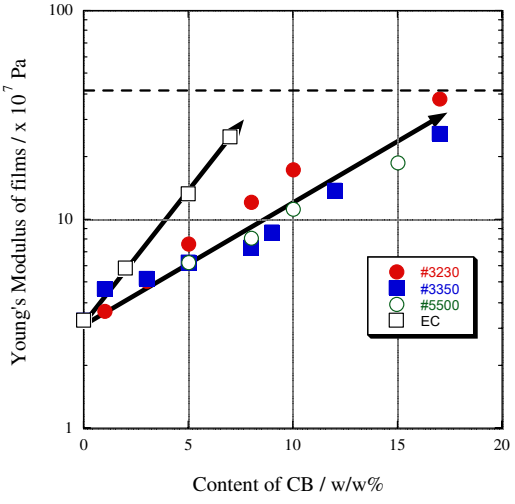

Fig.3 Dependence of CB content for Young's Modulus of Films.

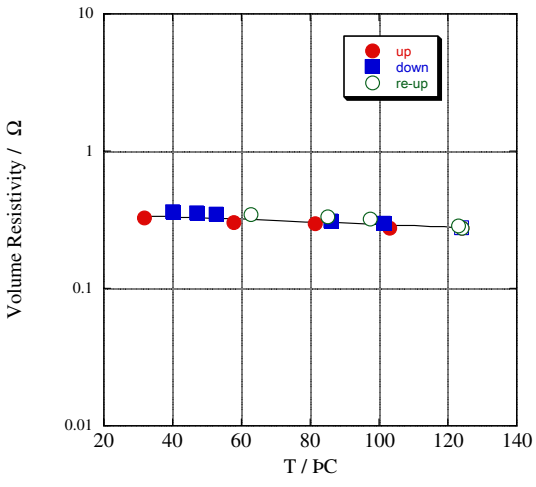

Fig.4 Temperature Dependence of Volume Resistivity of an EC film with CB content of 5 w/w%.