NOTES

Electric Current from Cotton Cellulose Sandwiched Between Metal Electrodes with Temperature Variation

The M_1–cotton cellulose–M_2 system, where M_1 and M_2 are two like or unlike metal electrodes, has been found to generate electric current while being heated uniformly under short-circuit condition. Ieda et al.[1] and Sawa et al.[2] observed current of similar type from some previously untreated polymers sandwiched between metal electrodes.

The dependence of the magnitude and direction of short-circuit current on the choice and combination of electrodes has been found to be similar to the findings of Ieda et al. The experimental procedure adopted in the present investigation is also the same as that of Ieda et al.[1]

The samples were made of cotton fabrics 250 μ thick. The currents under short-circuit condition (I_s) as a function of temperature (T) from Al–cotton cellulose–Cu or Cu–cotton cellulose–Al system using foil electrodes for four successive heatings are shown in Figure 1. It is seen that the current is reproducible in repeated heatings. Peak positions and shapes of the I_s-versus-T plots are also invariant for all the repeated heatings. A peak is seen to occur at 89°C, indicating a transition in cellulose at that temperature. While measuring thermal expansion of wood polymers, Ramiah and Goring[3] observed a transition at 80–110°C for Avory cellulose. The transition at 89°C obtained in this investigation might be the glass transition temperature (T_g) of the amorphous region of cellulose. Ogiara et al.[4] reported that the glass transition of cellulose occurs at different temperatures depending on the amount of water content.

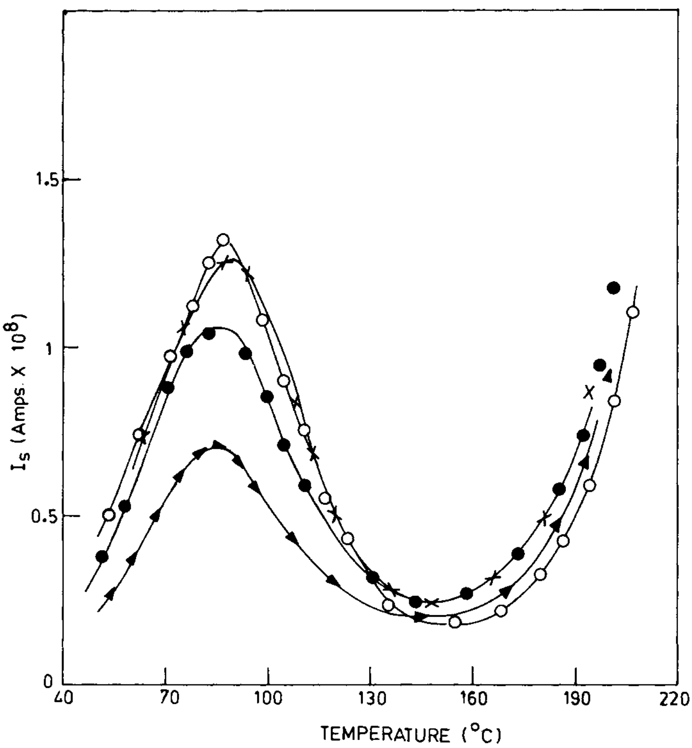

Fig. 1. Short-circuit current (I_s) from Al–cotton cellulose–Cu (1st–3rd heatings, negative current) and Cu–cotton cellulose–Al (4th heating, positive current) system as function of temperature. Electrode area = 4.0 cm²; thickness of sample = 250 μ; heating rate = 6°C/min: (O) 1st heating; (●) 2nd heating; (▲) 3rd heating; (X) 4th heating.

Journal of Applied Polymer Science, Vol. 23, 621–622 (1979)

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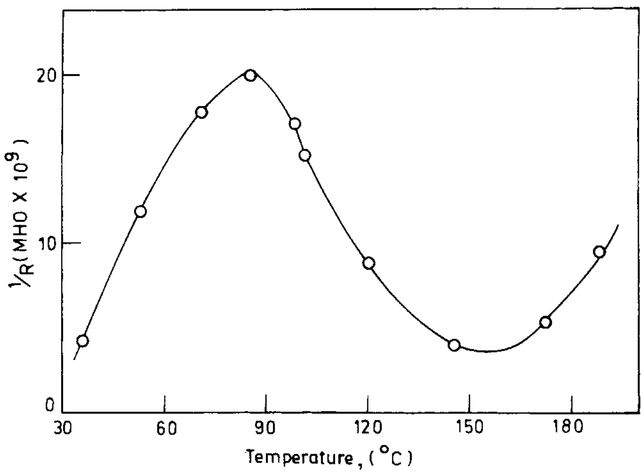

Fig. 2. Plot of reciprocal of resistance (I/R) of the sandwich system (currents from which are shown in Fig. 1) during 7th heating as function of temperature. Heating rate = 6°C/min.

During the seventh heating, electrical resistance of the sample (R) was measured at different temperatures with an externally applied voltage which was much higher than the maximum voltage that can develop across the sample due to heating. External voltage was applied momentarily (during the time of measurement of resistance at a particular temperature) to avoid any polarization. Figure 2 shows that the (I/R)-versus-T plot is similar in respect of shape and peak position to the I_s-versus-T plot (Fig. 1), implying that the metal–cotton cellulose–metal system may be assumed to be a galvanic cell in which the short-circuit current can be expressed as E/R, where E is the electromotive force and R is the resistance of the sample.

One of the authors (M.M.) gratefully acknowledges the financial support from the Ministry of Education, Govt. of India.

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Received February 17, 1978
Revised April 7, 1978