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NOTE

Effect of Filling of Red Mud on the Dielectric Constant of Polymethyl Methacrylate

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The paper describes the effect of red mud filler on dielectric constant of polymethyl methacrylate. The studies were carried out in the temperature range 35–80°C and frequency range 400 Hz to 100 KHz. The results also show that the filling of red mud increases the magnitude of dielectric constant of polymethyl methacrylate.

Polymer and metal, by virtue of their respective insulating and conducting properties, have a large history of use in diversified applications. Over the years the uses of polymers are increasing and polymeric materials have now become the part of our day to day life. As far as industrial uses of polymers are concerned, initially they were appreciated for their most peculiar properties like electrical insulating behaviour, heat insulation transparency, softness, flexibility etc. Later on, with the increase in the demand, their uses were extended to the applications in which the opposite properties are required, such as electrical conductivity, heat insulation, radiation screening, hardness, rigidity etc. and these applications were achieved by blending the polymers with suitable fillers[1, 2]. The addition of fillers in the polymers have been found to improve the flexuous modulus, dimensional stability, heat deflection temperature etc. of the polymers and also important in view of obtaining low cost and recyclable polymeric materials[3–5].

The present paper is devoted to exploring the effects of various external parameters like temperature, applied a.c. frequency, etc. on dielectric properties of a polymer polymethyl methacrylate (PMMA) after filling it with a cheap industrial waste, red mud.

The crystals of polymethyl methacrylate polymer were obtained from M/s IPCL, Baroda (India) and red mud (RM) powder (density 2.78 g/cm^3) was obtained from M/s BALCO, Korba (India). The film of the polymer was prepared by mixing PMMA and red mud by different weight ratio using solution cast technique[6, 7]. To carry out the dielectric measurements, small portions of the area 1.5 × 1.5 cm were cut from the film and silver paste (No. 1228), purchased from M/s Elteck Corporation, Bangalore (India), was applied on both the faces of each piece[8]. However, the dielectric constant (ε') was measured by using Hewlett Packard Impedance Analyzer (4192 ALF) over the frequency range 400 Hz to 100 kHz and in the temperature range 35° to 80°C.

Fig. 1 exhibits the variation in dielectric constant with the change in temperature at various frequencies for RM filled PMMA samples. It is observed from the graph that the dielectric constant increases with increasing temperature at all the frequencies. The graph also shows a decrease in the value of the dielectric constant with increasing applied a.c. frequency in the entire temperature range. Both the phenomena indicate the fact that like pure PMMA, RM filled PMMA is also a polar polymer and confirms the presence of dipoles in the giant molecular structure of the composite.

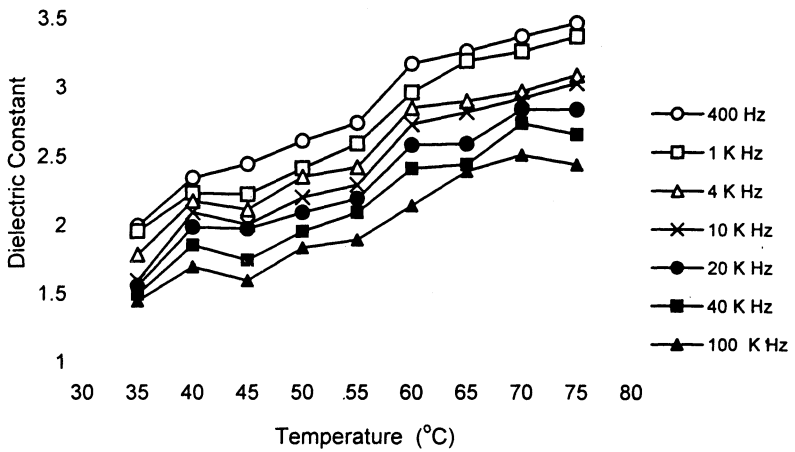

Fig. 1 Dependence of temperature on dielectric constant at different frequencies for red mud filled polymethyl methacrylate samples

The comparison of dielectric properties of red mud filled PMMA with pure PMMA indicates that the presence of filler increases the polarization behaviour of PMMA. This may be due to the presence of metallic nature of red mud, which converts PMMA from glassy to metallic state. It seems that with the addition of red mud, the effectiveness of intermolecular interaction of the kinetic units of the neighbouring chains of the glassy state of PMMA reduces, as a result of which an increase in the dielectric constant of the system takes place. The effect can also be explained on the basis of chain elongation, taking place due to the distribution of the glassy amorphous polar polymer red mud filled PMMA in the integrated space, which may have consequently resulted in the increase of dielectric constant[9, 10].

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