PERFORMANCE EVALUATION FOR PVC COMPOSITE SYSTEMS

II-PVC-MICA COMPOSITES

Y. M.S. El-SHAZLY, A.I.ALI*, R.R. ZAHRAN**, and B.A. GEBRIL****
*Egyptian Petrochemicals Company, Alexandria-Egypt

**Department of Chemical Engineering, Alexandria University, Alexandria 21544-Egypt

Introduction

PVC is a popular and inexpensive polymer that is widely exploited for its many advantages. Mica is a cheap mineral that is used for its high dielectric strength and for fire proofing applications. A resulting composite between the PVC as a matrix, and a filler of mica particles may find applications in low cost housing, ceiling boards, roof tiles and dry walling. In this study, physical and mechanical properties of blends of PVC and mica are studied. Moreover, the addition of the silane coupling agent as a binder between the two phases is studied [1]. Finally, the effect of weathering of the composite mechanical performance is reported.

Materials

Two formulations of PVC that are commonly prepared in the Egyptian Petrochemicals Company; Cable formulation (PPVC) and Profile formulation (UPVC) are used in this study as the matrix material. Mica were obtained as muscovite plates that were ground to fine particles of average size 1.44 µm. Vinyl tri methoxy silane, VS 604, a product of Union Carbide was used as the silane coupling agent.

Preparation of composite

PVC was blended with mica powder in the Brabender Plasticord PL2000 for 3 to 5 minutes depending on the type of PVC. Then the blend was compressed at high temperature in a Presa 120 TM Fabesint hydraulic press into a 3 mm thick plates. In the case of silane contained samples, the silane was sprayed on the mica before the barbender mixing.

Measurements

The specific gravity of the composite was measured using a pycnometer according to ASTM. The tensile and flexural tests were conducted in a Llyod tensile tesing machine, type LR5K+, with a load cell 500 dN. The Izod impact strength was measured using a Ceast Izod Impact tester, model 6546/000, equipped with a 2J Hammer. The Vicat Softening Point was measured using a Ceast Vicat apparatus, model 6505/000. Hardness measurements were conducted using two durometers, scale shore D for the rigid PVC composites and shore A for plasticized PVC composites. The fusion and stability properties were measured using a Plasticorder PL2000 Brabender. The loading weight was set to 5 kg. The fusion characteristics were evaluated at 180°C and 30 rpm in case of rigid PVC-Mica composites and at 160°C and 15 rpm in case of soft PVC-Mica composites. The stability properties were measured at 200°C and 60 rpm. Accelerated weathering for PPVC-composite samples was made using Atlas Weather-O-meter, model CI3000+. Tensile tests were carried for weathered specimens after periods of 100, 200, 300, and 400 hours. All tests were conducted according to the ASTM standards.

Results and Discussions

The density of the composite increased along with the increase in the content of the mica. However, the addition of silane decreased the density.

The addition of the mica has increased the Vicat Softening Point of the UPVC. Moreover, the addition of the silane to the composite increases the softening temperature with higher temperature at the 1% silane than at the 2% silane.

The addition of the mica to the UPVC has increased the Brabender Heat Stability Time. Furthermore, the silane addition has intensified this increase.

The fusion time has increased with the addition of the mica. However, the rate of increase with

the mica content was lower with the increase of the silane content.
It was also found that the mica addition decreased the fusion torque and the equilibrium torque. The silane had a pronounced effect in the decrease of the fusion torque (Figure 1).
There was no significant effect on the volume resistivity upon the addition of the mica. This might be due to the similarity of the volume resistivity of both phases.
The addition of the mica to the UPVC increased the Izod impact strength until 10% mica content and then it started decreasing to a value lower than the mica-free UPVC. The silane decreased the impact strength; however, the decrease was higher at 1% silane than at the 2% (Figure 2).
The addition of mica to PPVC has increased its hardness; on the other hand, it did not have any effect on the UPVC.
Mica also had increased the flexural and tensile moduli in the case of the UPVC and the tensile modulus of the PPVC. The tensile strength showed an increase with the 5% mica and then started to decrease at higher mica levels. However, the mica caused a sharp decrease in the tensile strength of the UPVC. Furthermore, the elongation at break has decreased in both types of PVC.
During weathering, there are simultaneous elimination of HCl, crosslinking and chain scission in the structure of the PVC, but at a particular period, one of these factors prevails over the others and this explains the change in the mechanical properties associated with the weathering period. It was found that the tensile modulus of the PPVC-mica composite shows an increases with the prolongation of the weathering period which extended to 400 hours. This increase was dependent on the amount of mica present as it was highest with the highest mica content. There was no support to show that the silane addition has any effect on this increase. Moreover, the weathering did not have any effect on the tensile strength behavior of the mica-PPVC composite; a decrease at mica content higher than 5%. The mica content did not have any effect on the elongation at break upon weathering except with the 2% silane samples, which showed a large decrease upon ageing.

Conclusion

Mica can be used as filler to PVC with many satisfactory outcomes. The properties of the resultant composite will depend on the amount of mica, the type of PVC, and the presence of a coupling agent. These properties should be studied upon deployment as mica can have drastic changes on the properties of the PVC as was shown by the decrease of the impact strength and the elongation at break. Also ageing effect should be monitored.

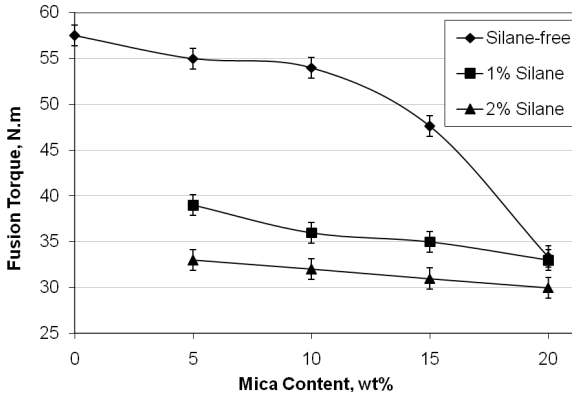

Figure 1; Effect of the mica and silane on the fusion torque of the UPVC.

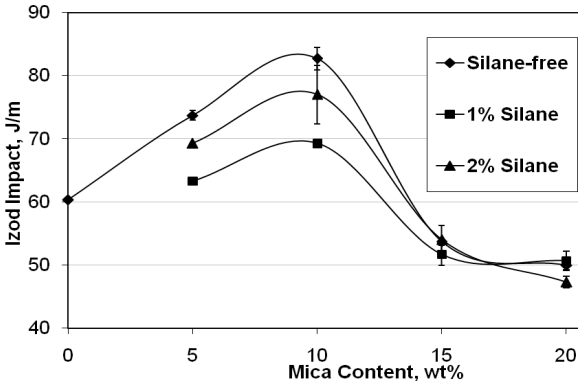

Figure 2; Effect of mica and silane addition on the Izod impact strength of the UPVC.

References:

1. L. M. Matuana, C. B. Park, J. J. Balatinecz, Journal of Vinyl and Additive Technology, 1997, 3, 265-273.

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