ATOMIC FORCE MICROSCOPY INVESTIGATION OF MICROSCOPIC FLOW OF MATRIX LEADING TO INTERPHASE FORMATION IN SHORT MELAMINE FIBER REINFORCED RUBBER COMPOSITES

R.S. RAJEEV
UNIVERSITY OF SOUTH CAROLINA
Postdoctoral Research Fellow

R.S. Rajeev*, S. Bandyopadhyay#, S.K. De§ and A.K. Bhowmck† *Department of Chemical Engineering, University of South Carolina, Columbia, USA #School of Materials Science and Engineering, The University of New South Wales, Sydney, Australia §College of Leather Technology, Salt Lake City, Kolkata, India †Rubber Technology Center, Indian Institute of Technology, Kharagpur, India.

ABSTRACT

Melamine fiber reinforced elastomeric composites are potential candidates as insulators for launch vehicles by virtue of their low density and excellent ablative properties. In this paper the investigation performed using atomic force microscopy (AFM) on the interphase formation in short melamine fiber reinforced rubber composites is reported. Three different rubbers namely, ethylene propylene diene (EPDM) rubber(1,2), maleated EPDM (mEPDM) rubber(3) and acrylonitrile co-butadiene rubber (NBR)(4) were used as the matrix materials. A dry bonding system comprising of resorcinol, hexamethylene tetramine and hydrated silica (popularly known as HRH dry bonding system) was also incorporated in the matrix for enhancing the fiber-matrix adhesion. The results of the static and dynamic mechanical properties of the composites proved the reinforcing capability of the melamine fiber the properties being significantly better for the composites containing the dry bonding system. Ageing of the composites at higher temperature for prolonged period further increased the tensile strength and modulus. A probe into the interphase using AFM revealed the presence of a thick, well-defined fiber-matrix interphase in the composites with the dry bonding system. The fiber surface morphology as well as the fiber-matrix interphase was found to be smooth for composites devoid of the dry bonding system. For the aged fibers, AFM studies revealed an increase in the surface roughness. This presents a greater interfacial surface area enabling the rubber matrix to flow into the cervices of the roughened fiber, causing improved wetting. The better tensile strength and modulus of the aged composites could be as the consequence of this excellent mechanical interlock wetting, which was evident from the AFM images. All the three rubber matrices investigated portrayed similar behavior. The studies reveal that melamine fiber is a suitable reinforcing fiber for EPDM, mEPDM and nitrile rubber matrices, and that AFM is a useful technique to investigate the microscopic flow of the matrix onto the fibers i.e., wetting.

Key words: atomic force microscopy composite interphase melamine fiber rubber, wetting.

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