SURFACE STUDY OF PLASMA TREATED POLYETHYLENE FIBERS BY AFM

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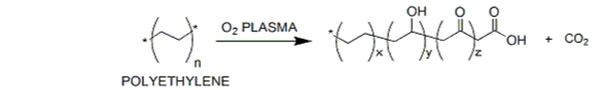
Introduction and Objective

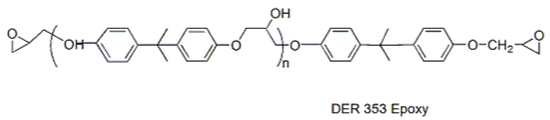
UHMW polyethylene was oxygen plasma treated under ambient pressure and temperature. Variations in the plasma exposure time at a constant flow rate of 1LPM lead to the surface morphology change, which reflects on mechanical properties of a corresponding composite.

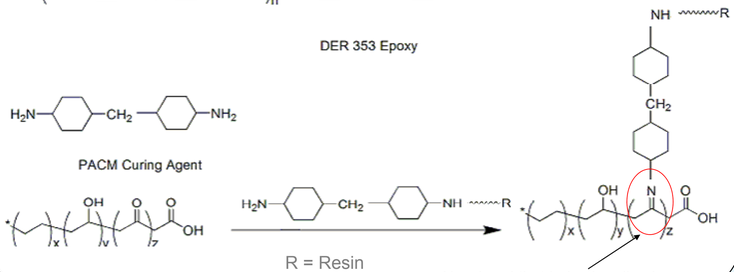
Objectives:

- Correlate the Interfacial Shear Strength (IFSS) and energy absorption of polyethylene-epoxy microcomposite with plasma exposure time.
- Investigate the surface morphology of untreated and plasma treated polyethylene fibers by AFM technique and correlate surface morphology change to interfacial properties of the polyethylene-epoxy composite.

Incorporation of Functional Group on Fiber Surface

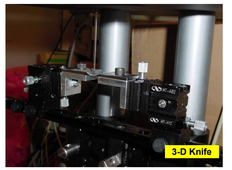


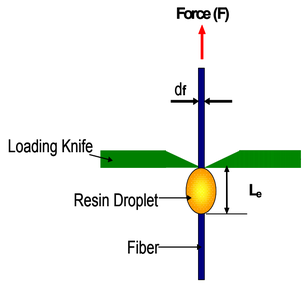




Effect of plasma exposure time on interfacial properties

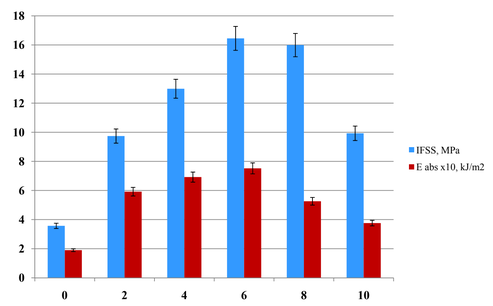
Effect of plasma exposure time variations on IFSS and energy absorption was studied through Single Filament Microdroplet Test. Flow rate of oxygen plasma was maintained at 1L/min.



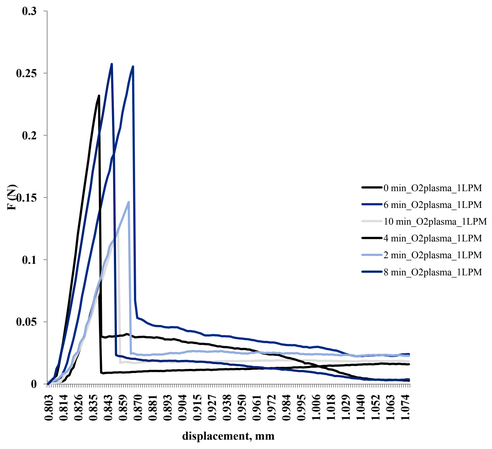


$$IFSS = \frac{F_c}{\pi \cdot d_f \cdot l_e}$$

Single Fiber Microdroplet Test



Single Fiber Microdroplet Test

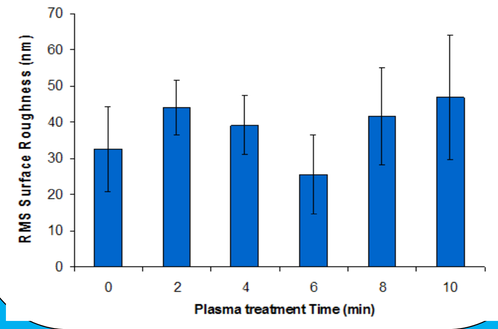


Observations from Microdroplet test

- Interfacial shear strength and energy absorption of polyethylene fibers show an increasing trend up to 6 minute of plasma treatment. After that they show decreasing trend with plasma exposure time.
- The initial increasing trend could be associated with more covalent bond formation after plasma treatment.

Surface roughness study by AFM

Surface morphology of untreated and samples plasma treated for 2, 4,6, 8 and 10 minutes were investigated by using Dimension 3100 Atomic Force Microscope in



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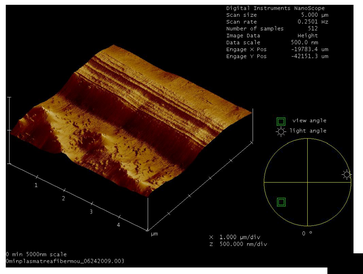
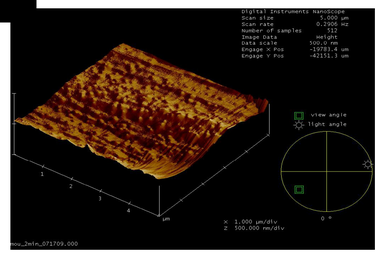
(Continued)

3D AFM Images of Fiber Surface

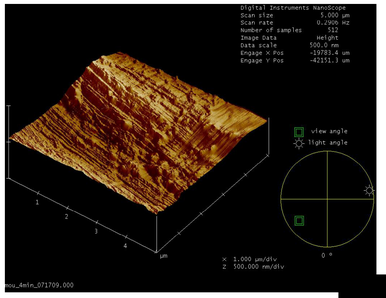


Untreated Spectra

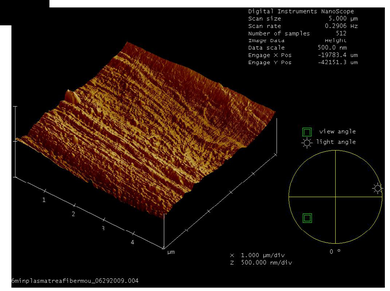


2 min plasma treated

3D AFM Images of Fiber Surface

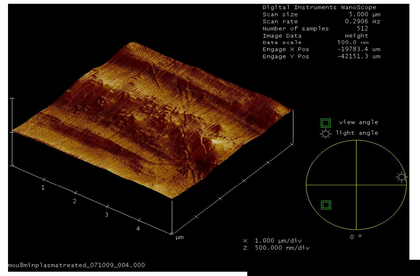


4 min plasma treated

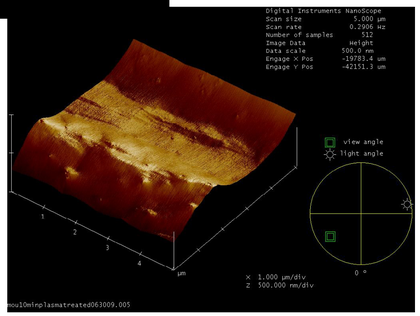


6 min plasma treated

3D AFM Images of Fiber Surface



8 min plasma treated



10 min plasma treated

SUMMARY

- Oxygen Plasma treatment increases the IFSS and energy absorption and so helps in improving the adhesion strength of the fiber to the epoxy resin. Variation in plasma exposure time can be effectively used to tailor the interfacial properties of polyethylene-epoxy composites.
- There is no direct correlation between interfacial properties and surface morphology .

FUTURE WORK

- Effect of change in flow rate of oxygen plasma on interphase and morphology will be studied.
- Functional groups concentration on the fiber surface will be determined by XPS and Fluorescence Titration.
- Further investigation of the morphological changes in a quasi-static sliding region on a fiber surface by AFM is needed.
- SEM imaging to look at the composite failure modes.

ACKNOWLEDGEMENTS

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