

Introduction

The present thesis covers a systematic and detailed investigation on the applications of plasma modified Polyethylene powder in combination with natural materials. Plasma modified Polyethylene has been used in two different purposes. One is as matrix for natural fiber composite and other is as fillers in natural rubber. Plasma surface modification makes the polymer more polar and active, which increase its applications in many ways. Plasma modification increases the surface free energy and polarity that improves the adhesion properties which open more applications in polymer technology.

Motivation of the work

Plasma treatment generates wide range of reactive species in the treated system. This also improves its surface micro-hardness and surface roughness due to the bombardment of high energy radicals and ions. The functional groups present on the modified surface can interact with hydroxyl groups of cellulose fibers which improved interfacial adhesion and properties of the composites.

Discussion

- The composite prepared from PPE and bleached fibres showed the best properties. The tensile strength was increased by around 100% in the case of PPET biocomposite where as it was only 10% for PET biocomposite than neat polymer.
- This is because of the interaction between the polar groups on the polymer surface and hydroxyl groups of the cellulose fibre. As a result of the high degree of interfacial interaction, the stress transfer from the matrix to the reinforcement is very efficient.
- It could be also explained by the formation of small capillary between the PE and the fibre whereas good adhesion between the PPE and fibers such capillary was not built
- SEM images showed that a strong interfacial interaction between natural fiber and polymer matrix is possible with plasma modification of PE matrix.

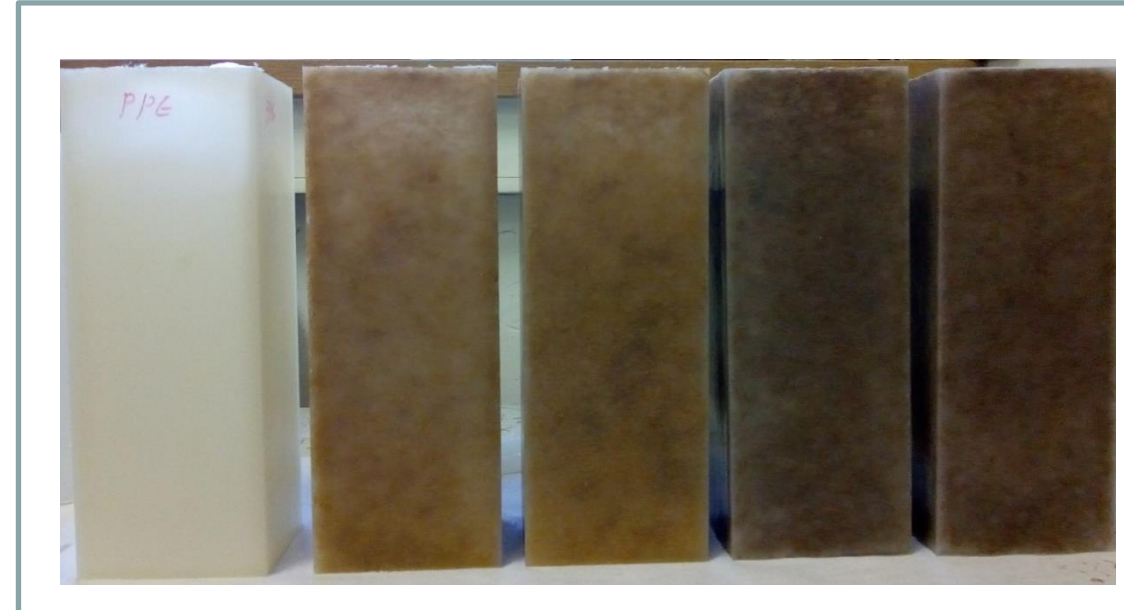
Experiments and Results

PPE natural fiber composites

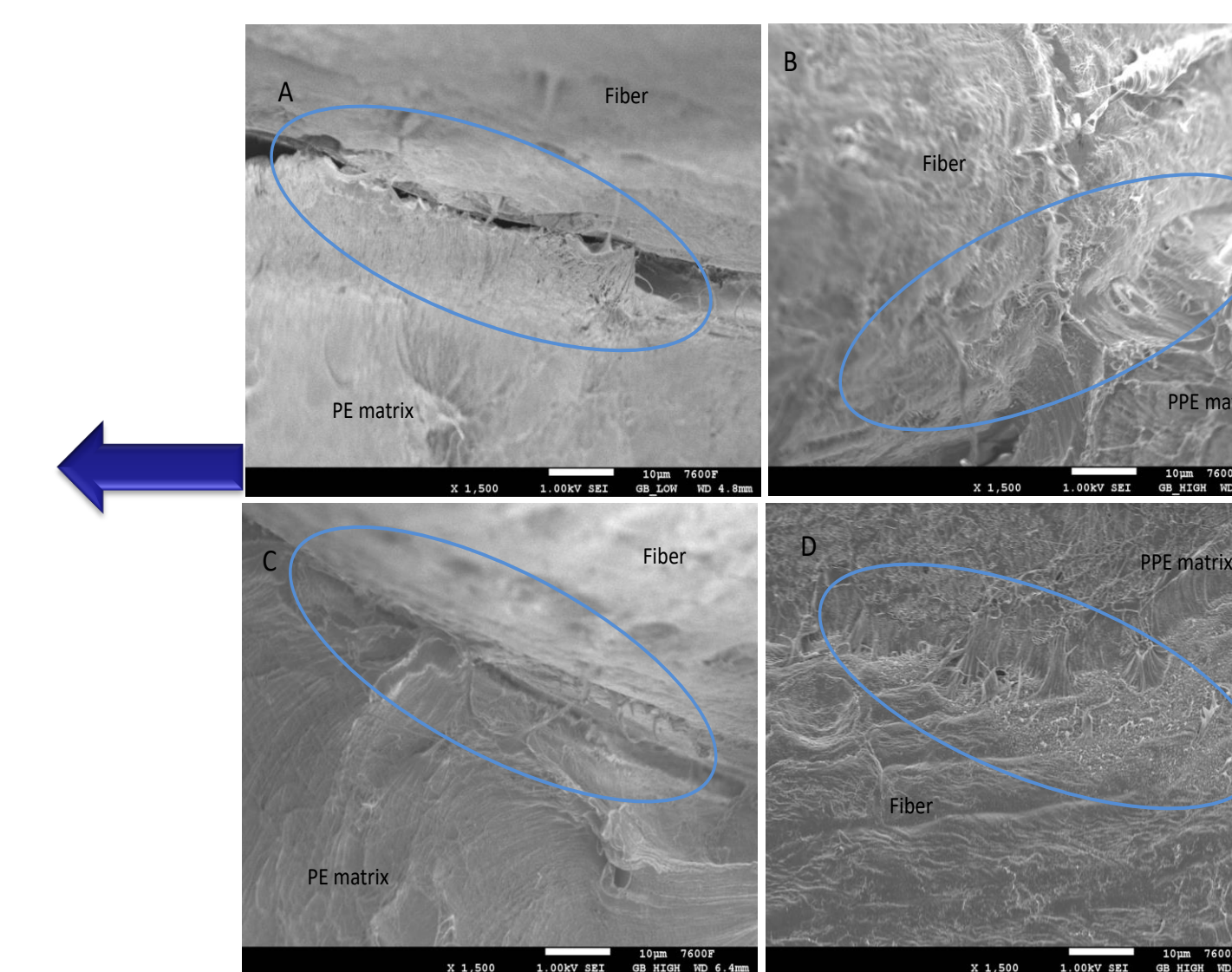
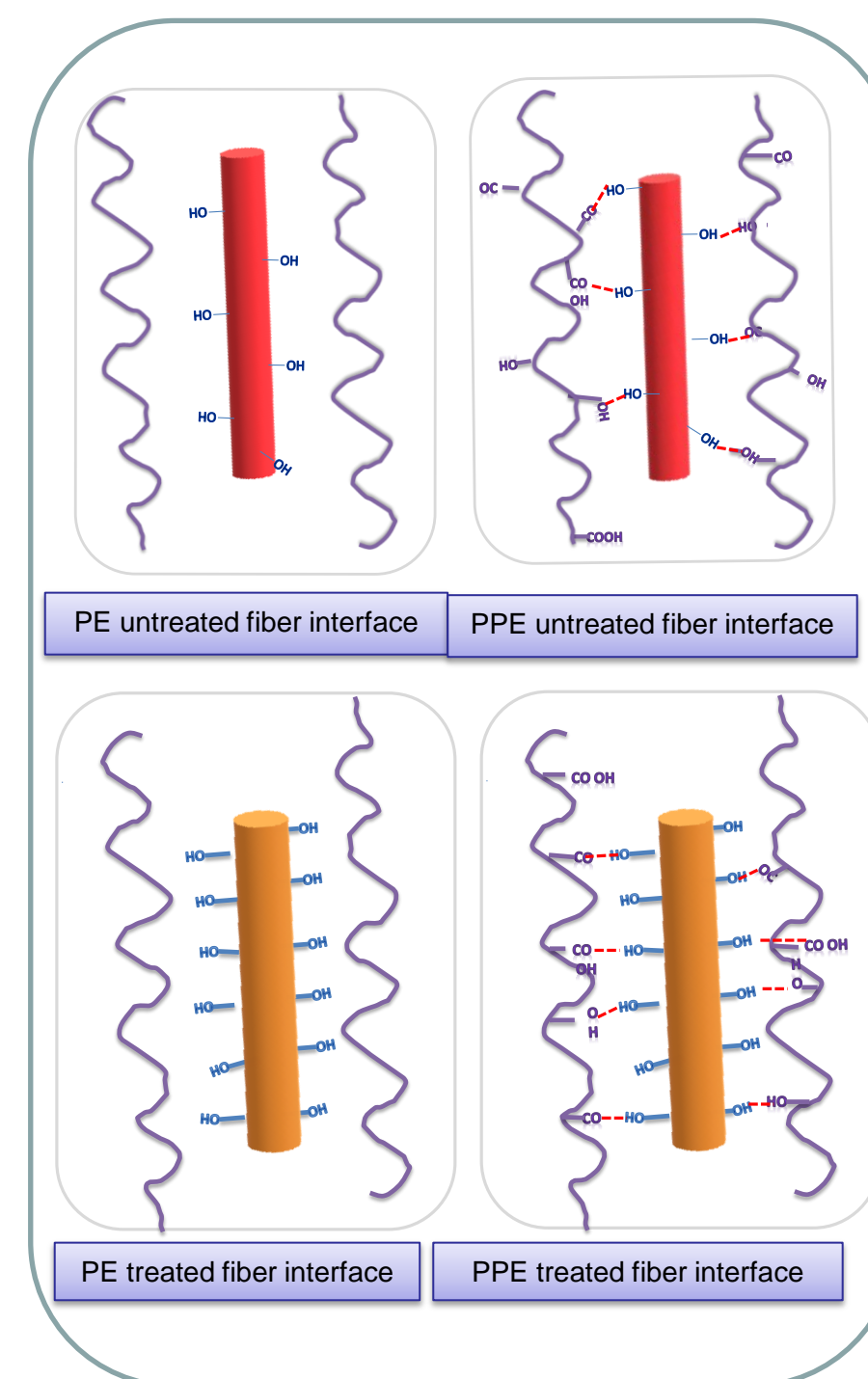
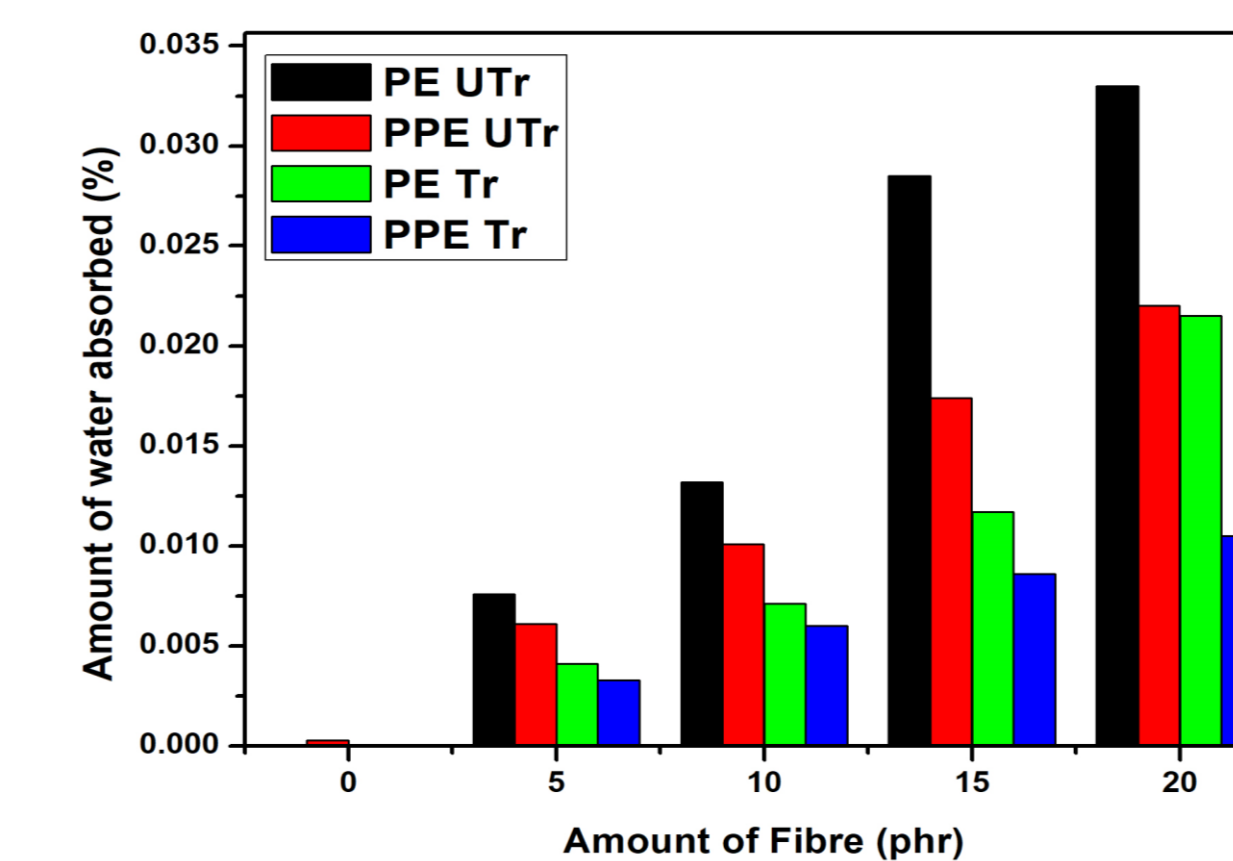
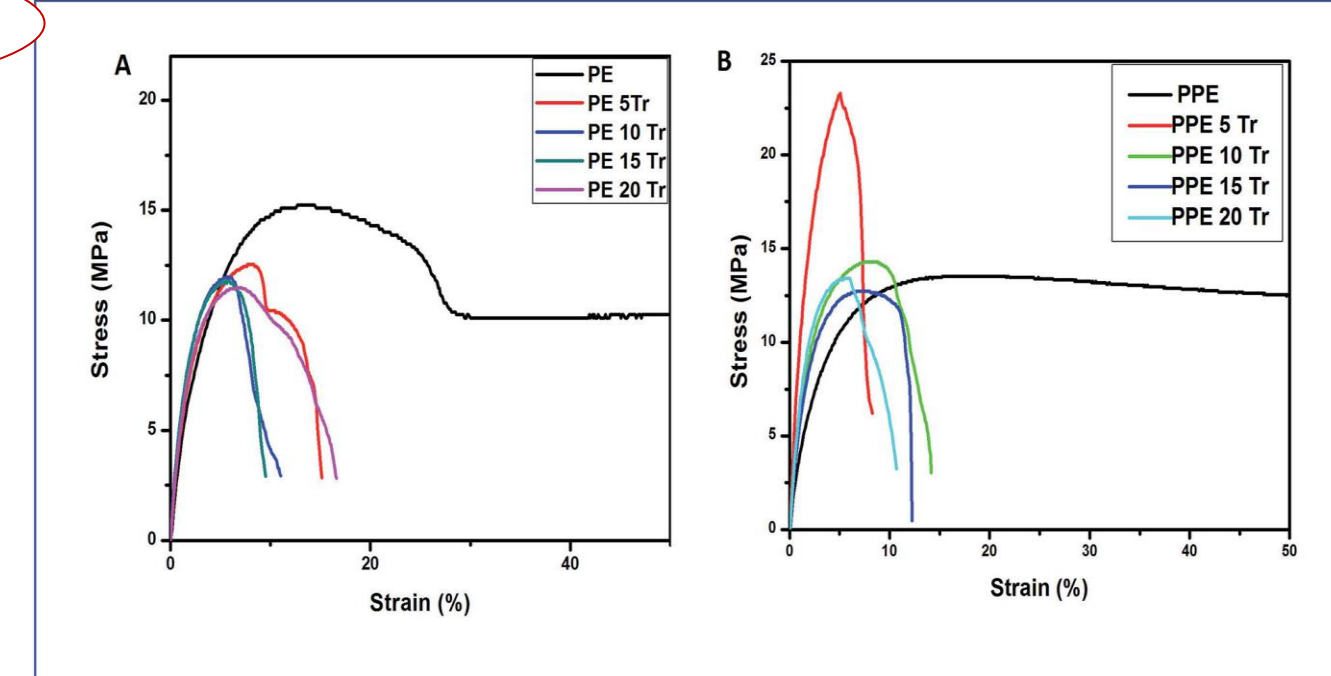
Compression Moulding



Rotational Moulding

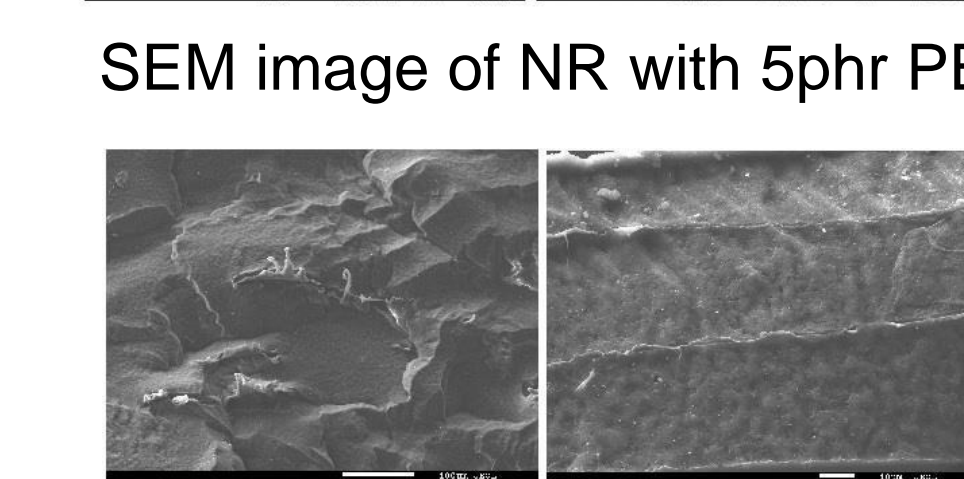
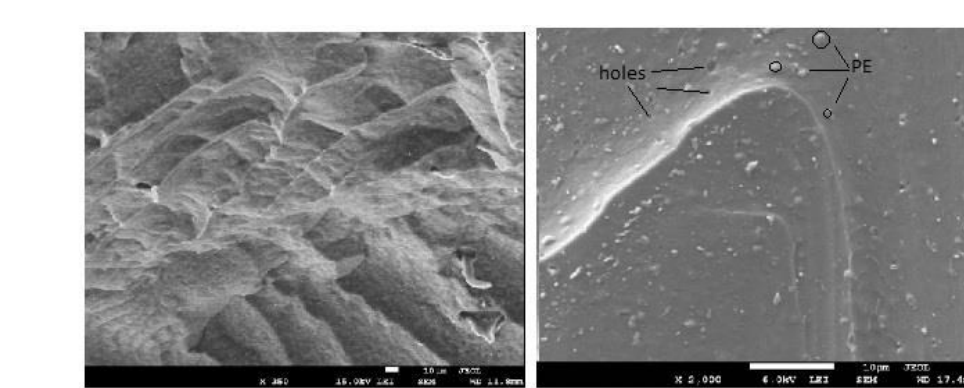
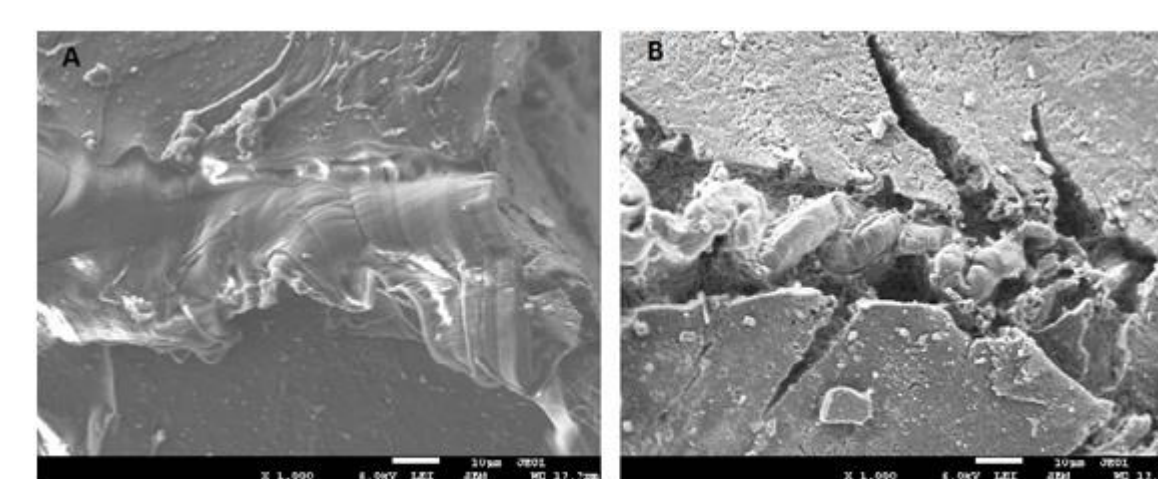


Injection Moulding



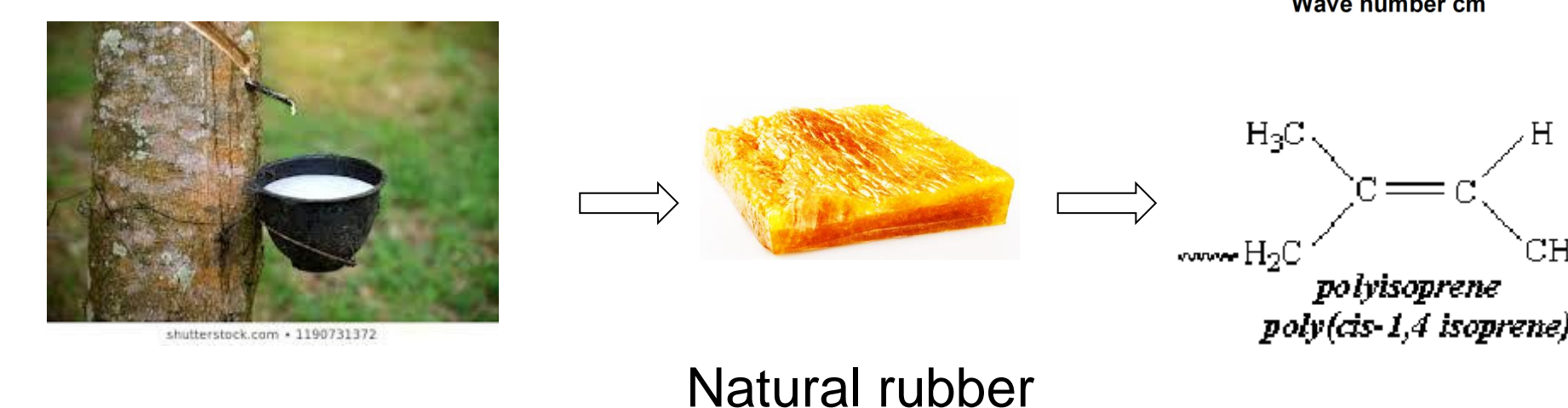
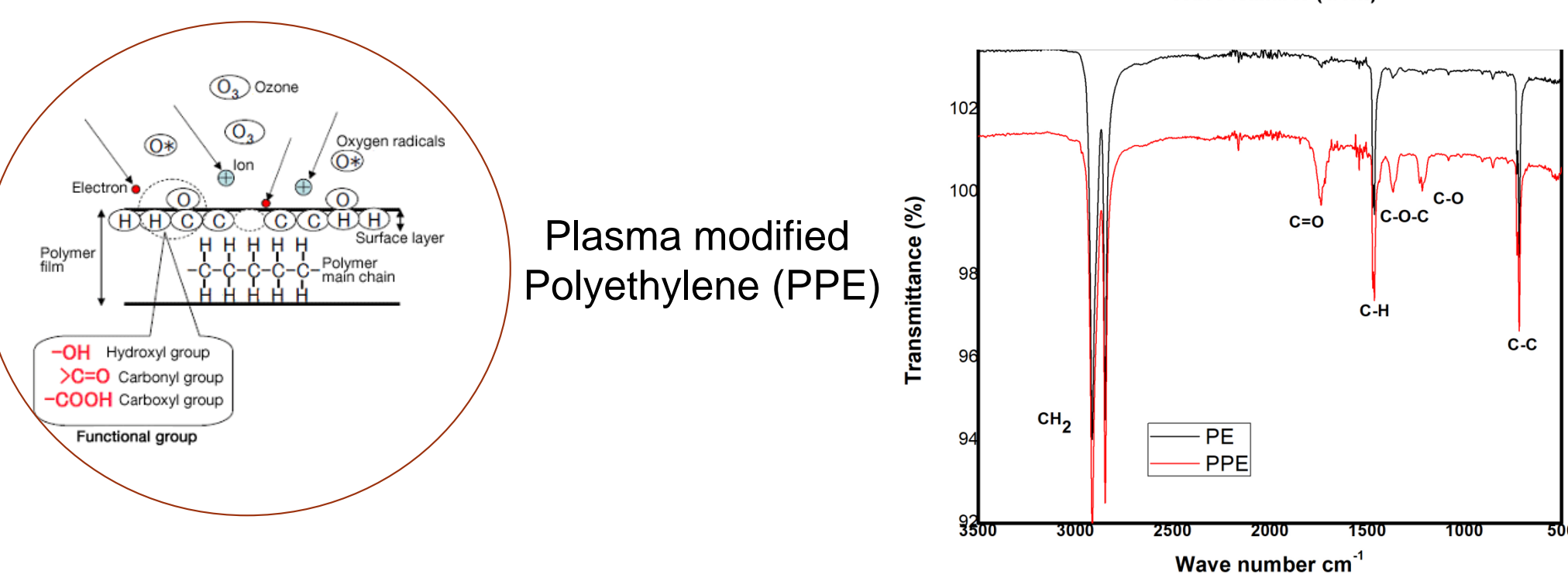
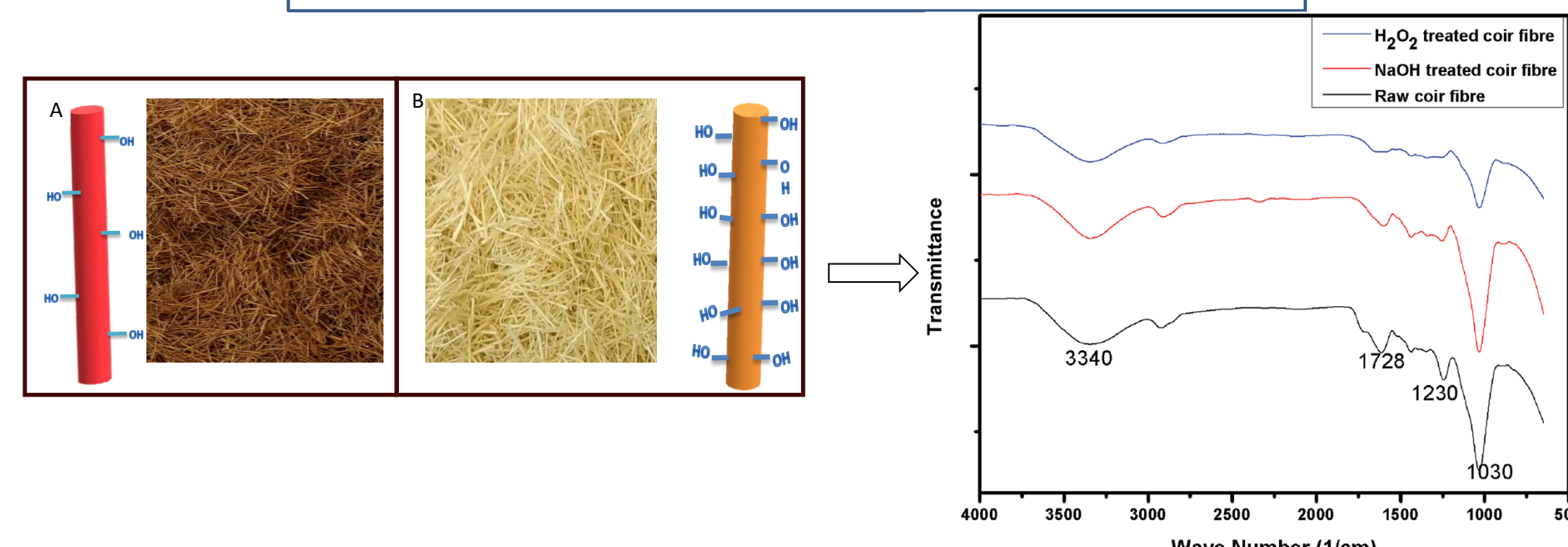
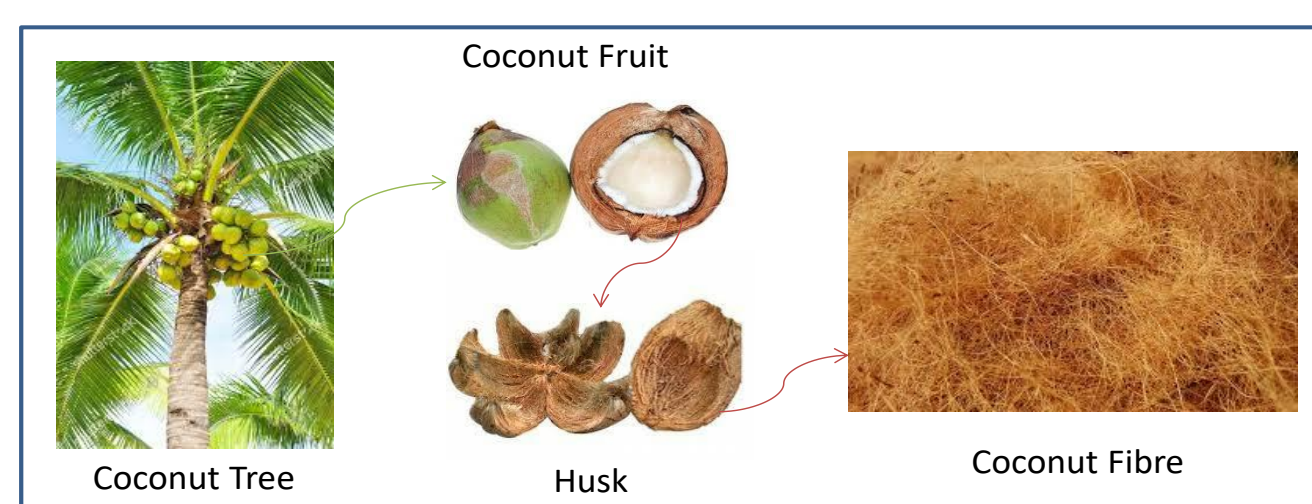
SEM image of a) PE-untreated fiber composite, b) PPE-untreated fiber composite, c) PE-treated fiber composite and d) PPE-treated fiber composite

NR/PPE Composites



SEM image of NR with 5phr PPE

Materials



Meeting Thesis goals

- To investigate the effect of plasma modified PE as matrix for natural fiber composites. Plasma modified PE based composites showed higher mechanical properties and lower water absorption. Morphology of the composites reveals that there is a good interfacial interaction between coir fiber and PPE matrix and a good wetting of fiber by the matrix eliminated the possible micro voids.
- Development and optimization of plasma modified PE Natural fiber composites for rotational moulding. Natural fiber composites were successfully manufactured via rotational moulding with improved mechanical properties and reduced water absorption.
- To investigate the effect of plasma modified PE as filler in Natural rubber composites. plasma modified PE showed high degree of phase separation and a tendency to agglomerate due to the polar-polar cohesive interactions among them.

Author's publications Linked with the thesis

- Sari P. S., Petr Spatenka, Zdenka Jenikova, Yves Grohens, and Sabu Thomas. "New type of thermoplastic bio composite: nature of the interface on the ultimate properties and water absorption." RSC Advances 5, no. 118 (2015): 97536-97546.
- Sari P. S., Petr Spatenka, Evgeny Anisimov, and Sabu Thomas. "Plasma Modified and Unmodified Polyethylene as Filler in Natural Rubber Compounds: Morphology, Cure Behavior and Vulcanization Kinetics." In Macromolecular Symposia, vol. 381, no. 1, p. 1800135. 2018.
- Sari P. S., Zoya Ghanem, Zdenka Jenikova and Petr Špatenka, "Composite with short fibers and plasma-treated polyethylene matrix prepared by rotomolding technology" submitted to SAMPE 2019 - Charlotte, NC.(under review)
- Sari P.S., Petr Spatenka, Zdenka Jenikova, Zoya Ghanam, and Sabu Thomas. "Effect of plasma modification of Polyethylene on natural fiber composites prepared via rotational moulding" (submitted to Composites Part B: Engineering)