CHAPTER IV

CONCLUSIONS AND FUTURE WORK

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1. The preparation of composites with high fiber volume content (above 60 vol.%), good mechanical properties and adequate fiber-matrix adhesion was possible using a solvent prepregging technique with continuous lyocell fibers.
2. Continuous lyocell fibers offer several advantages over lyocell fabric in terms of matrix application and control over processing conditions.
3. Matrix application by wet powder prepregging is limited by particle size of CAB. Smaller particles (<15 μm) are needed for adequate matrix uptake by the fibers, and for uniform matrix application.
4. Matrix application by melt processing produces attractive composites with fewer voids and lower water absorption than other processing methods. However, nonuniform fiber–matrix distribution and poor wetting of the fiber by the matrix resulting in interfacial failure are serious drawbacks.
5. Matrix application by solution processing provides uniform matrix distribution, the possibility of high fiber content in the composite, and excellent wetting of fibers by the matrix. Void formation due to entrapped solvent can in part be avoided if the panels are consolidated under vacuum.
6. Keeping consolidation time constant, lower consolidation temperatures (< 200^{o}C) produce less discoloration, but high void content and high water absorption. Although discoloration occurs at higher consolidation temperatures, the composite properties

are better in terms of void content and water absorption. Mechanical properties are not affected by consolidation temperature in the range of 180^{o}C to 210^{o}C.

7. Modulus and tensile strength were found to increase with incorporation of lyocell fibers while ultimate strain values decreased. A modulus of 21.5 GPa and a maximum strength of 251.7 MPa were achieved for a fiber volume fraction of 66.5% compared to 0.8 GPa and 76 MPa for the matrix, respectively.
8. Void contents were higher than those normally found in comparable carbon fiber composites.
9. Weight gains by water absorption were in the range of 7 to 30% by weight. This is very high compared to carbon or glass fiber composites (around 1-2%).

FUTURE WORK

Recommendations for future work include :

1. The time-temperature-pressure consolidation cycle should be optimized for cellulose fiber–CAB matrix composites. This study was able to screen only the effects of various temperatures for consolidation; pressure and time were kept constant.
2. Other mechanical properties, such as impact strength and bending tests, may provide more understanding into the performance of these composites.
3. Other conventional matrix material systems, which may be cheaper compared to CAB, such as polyethylene, polypropylene or polystyrene should be studied. Other biodegradable thermoplastics, such as polycaprolactone, are also viable matrix materials. Thermosets (especially epoxies) may have advantages over thermoplastics in terms of thermal stability, moisture absorption and mechanical properties.

4. Dry powder prepregging using an air fluidized bed is a viable alternative to the matrix application methods reviewed in this study. However, it requires matrix particle sizes smaller than 10 μm in diameter. Though this particle size range is not available commercially for CAB, any other matrix material of similar particle sizes can be used.
5. Dimensional stability measurements in different moisture environments are important and may be considered in future studies. One of the methods is the linear expansion test. It measures the change in length of the specimen to changes in moisture content using the relation: [60].

   Linear expansion (%) = $[(L_{90}-L_{50})/L_{50}]$ x 100

   L_{90} = length at 90% RH

   L_{50} = length at 505 RH

   Thickness swelling and water absorption can also be calculated using similar equations.
6. Lower molecular weight CAB can be used for better melt-processability and lower void volume.
7. Higher fatty esters can be used for lowering the consolidation temperature and increase melt flow.
8. Further investigation and feasibility studies of the aminolysis method of fiber weight content analysis is required.