

# Feasibility of Manufacturing Paper-Plastic Laminates Using Waste Paper

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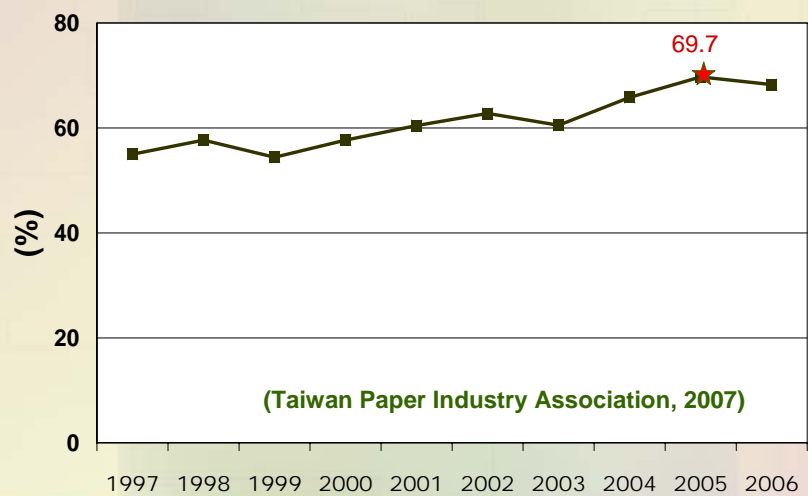


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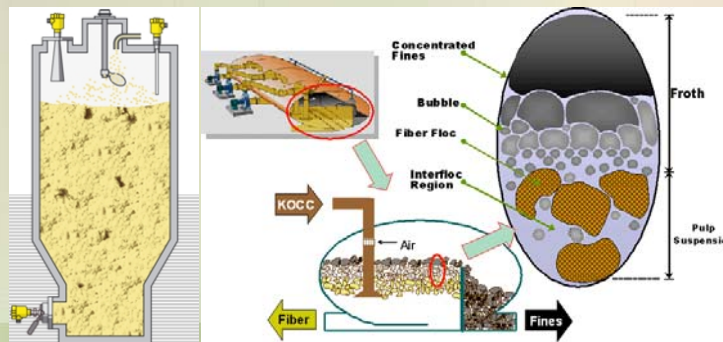
## Some Statistics. . . . .

### Waste Paper Recovery Rate in Taiwan



## Paper Recycling Procedures. . . .

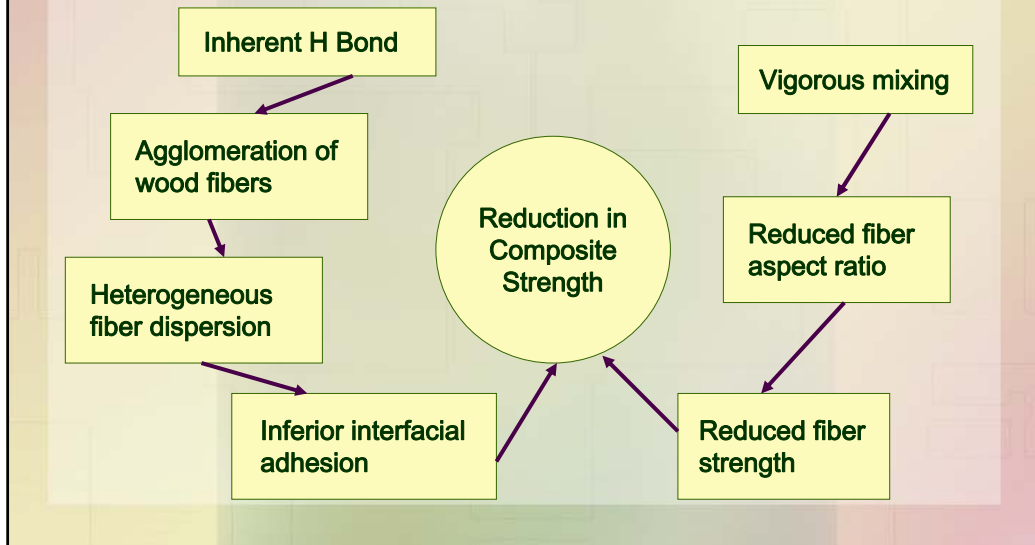
- ❖ Collection
- ❖ Classification
- ❖ Disintegration
- ❖ Washing
- ❖ Deinking
- ❖ Cleansing
- ❖ Bleaching
- ❖ Forming
- ❖ Drying



## Some Questions. . . . .

- Is there other options for Paper Recycling?
- Can other materials be reclaimed from the waste stream and combined with waste papers?
- Is woodfiber plastic composites a possibility?

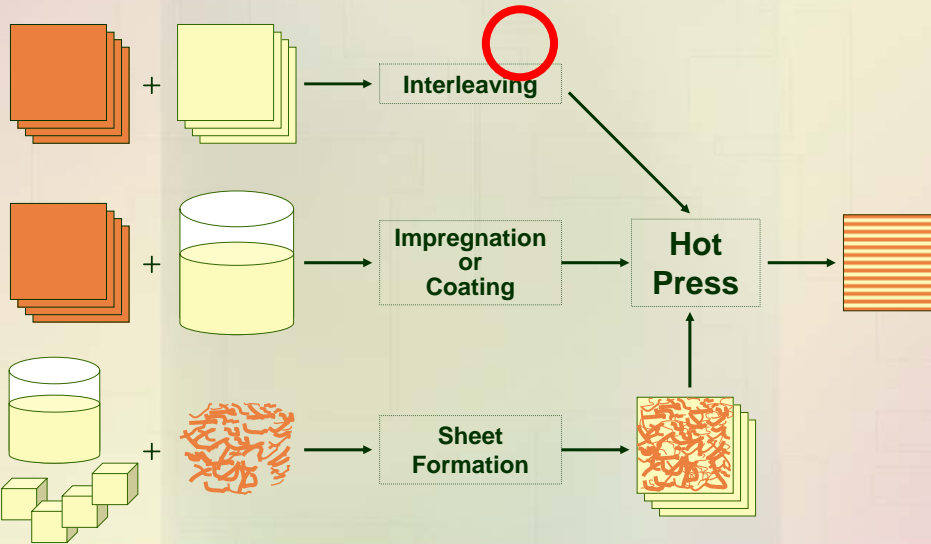
## Some Problems with Woodfiber Plastic Composites



## Why Paper-Plastic Laminates?

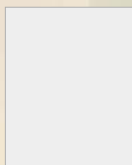
- Avoid elaborated paper recycling procedures....
- Reduce agglomeration b/w fiber and plastic
- Preserve aspect ratio of fiber
- Preserve H-bond of paper

## How PPL is Made?

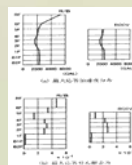


## Material

- Paper: office paper



NP, Not-Printed



P, Printed

- Plastic: PE films, 0.03mm, 0.06mm, 0.09mm



V, Virgin

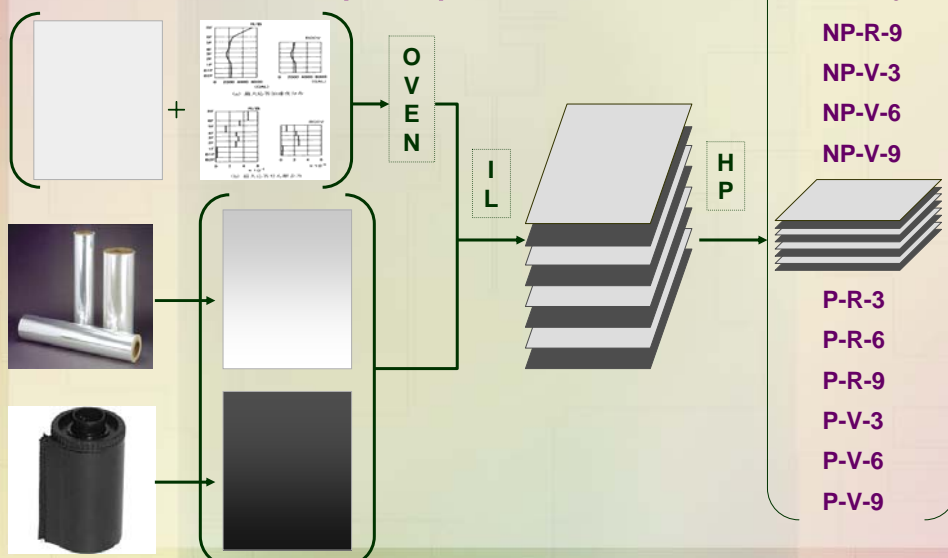


R, Recycled

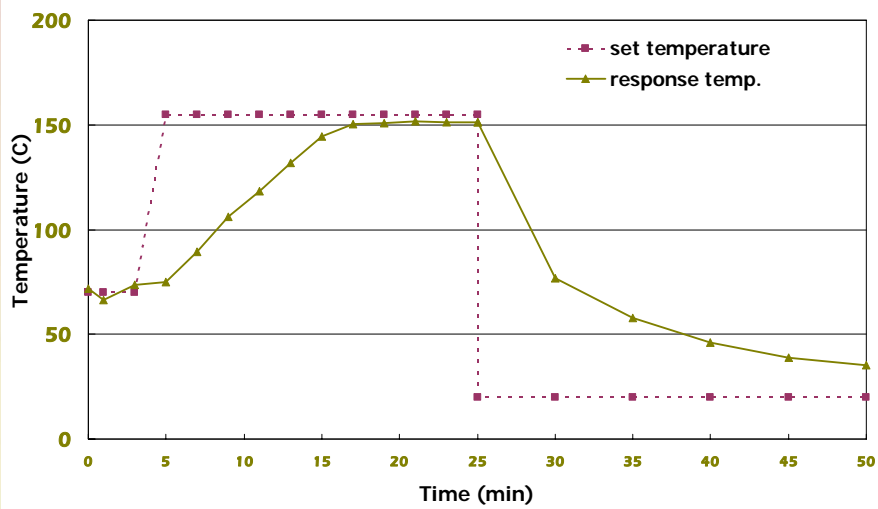
## Factors of Interest. . . . .

- Paper type (P, NP)
- Plastic type (V, R)
- Plastic film thickness (0.03, 0.06, 0.09 mm)

## Methods: preparation



## Typical Hot Press Scheme

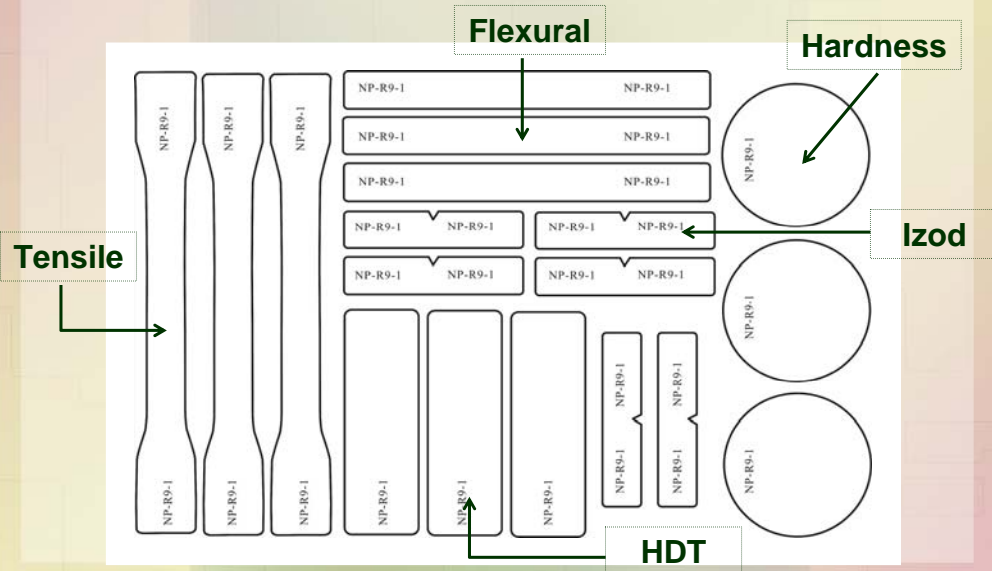


## Methods:

### Mechanical Properties

- Flexural Properties (MOR<sub>b</sub>, MOE<sub>b</sub>)
- Tensile Properties (MOR<sub>t</sub>, MOE<sub>t</sub>)
- Notched Izod Impact Bending
- Hardness (Shore D)
- Heat Deflection Temperature

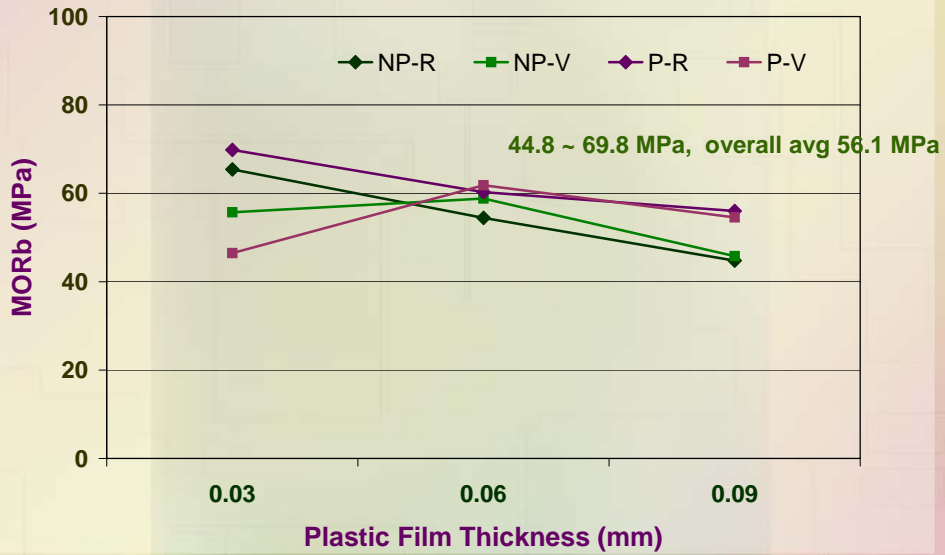
## Sample Preparation Scheme



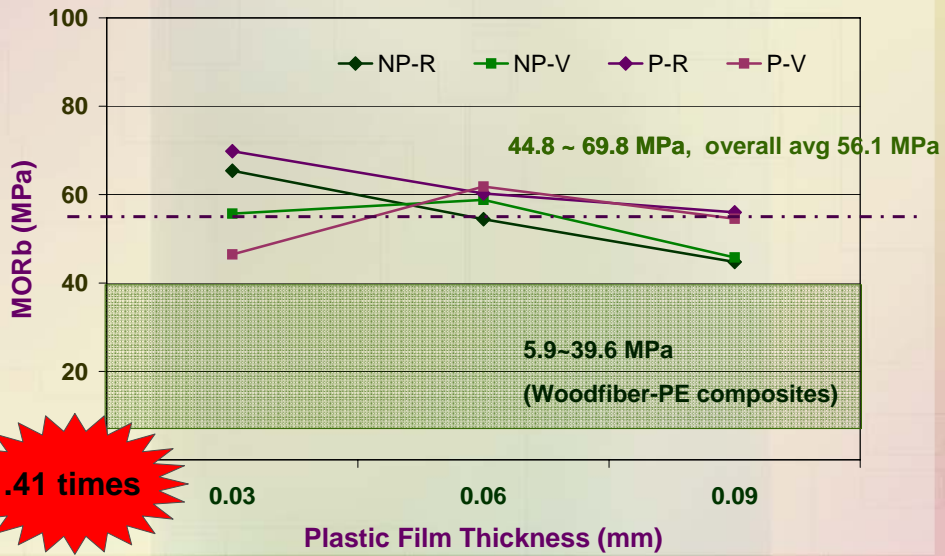
## Resulting PPLs

- Treatment combination: 12
- Replicate: 5
- Sp/Gr: 0.93 to 1.05 gm cm<sup>-3</sup>
- Compaction ratio: 1.17 to 1.23
- Fiber loading: 48, 60, and 72%

### Flexural Properties - MORb

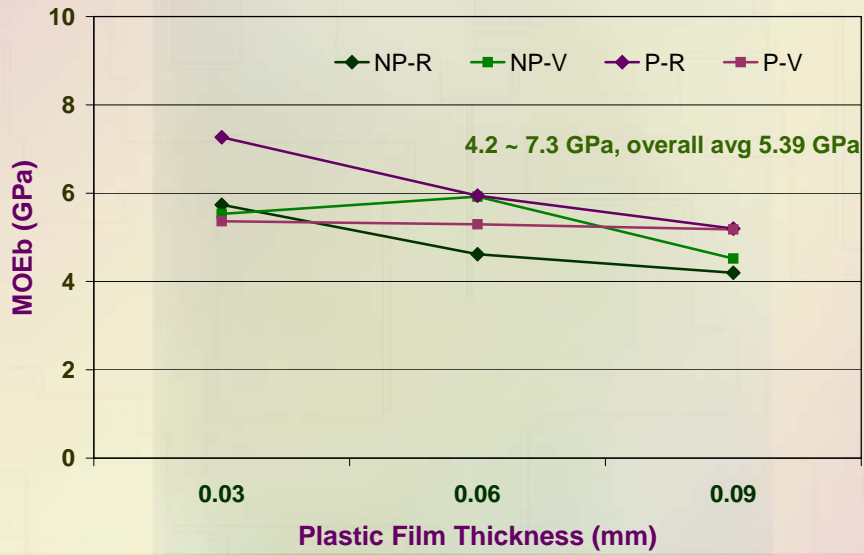


### Flexural Properties - MORb

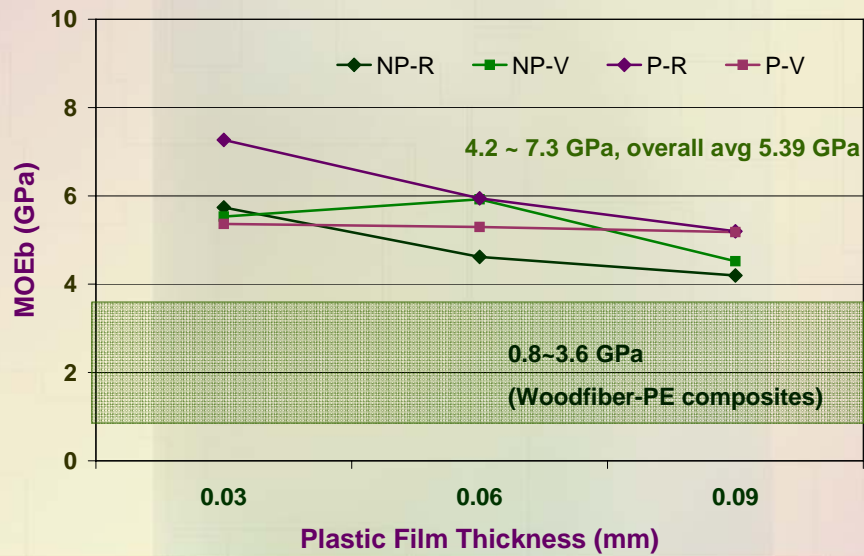




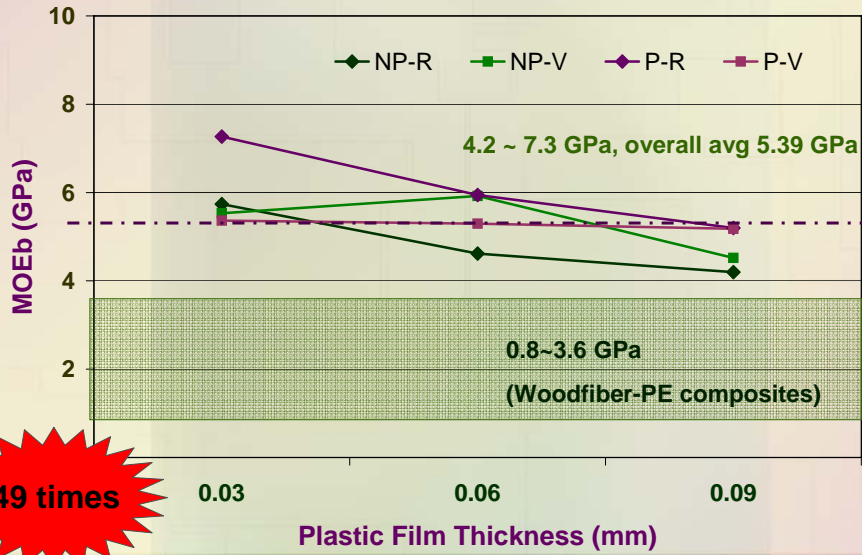
### Flexural Properties - MOEb



### Flexural Properties - MOEb

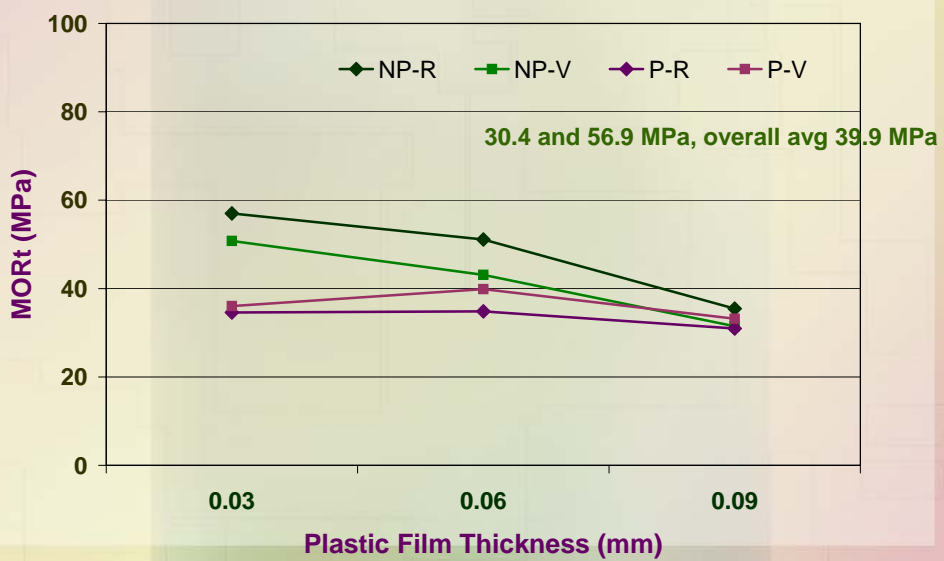


### Flexural Properties - MOEb

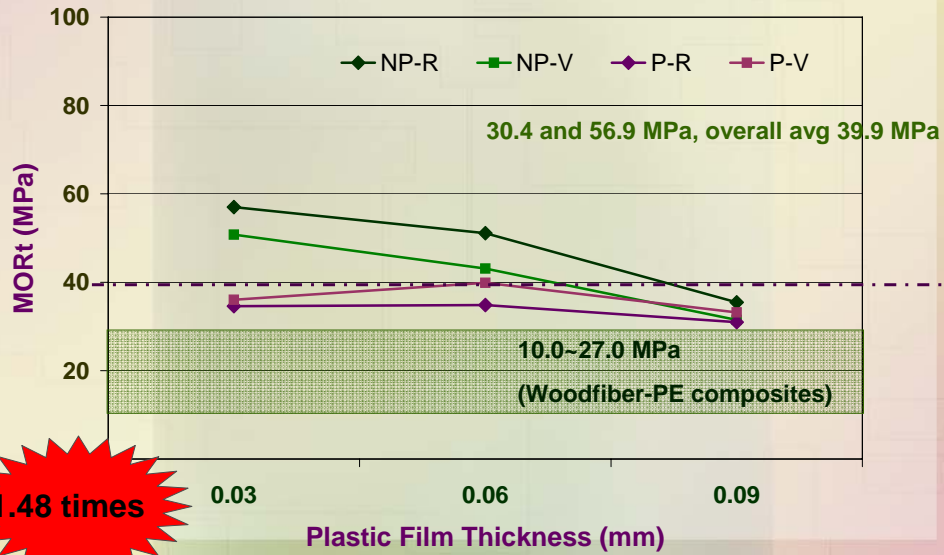


**1.49 times**

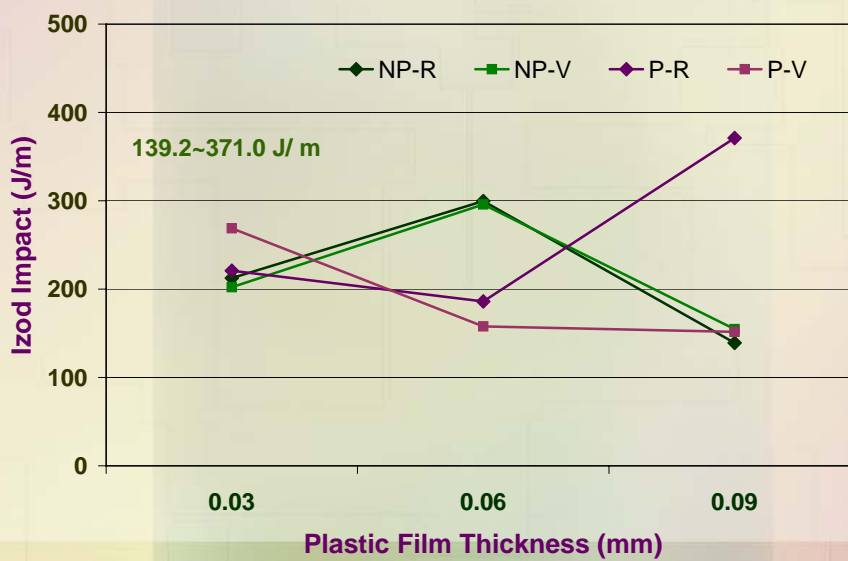
### Tensile Properties - MORT



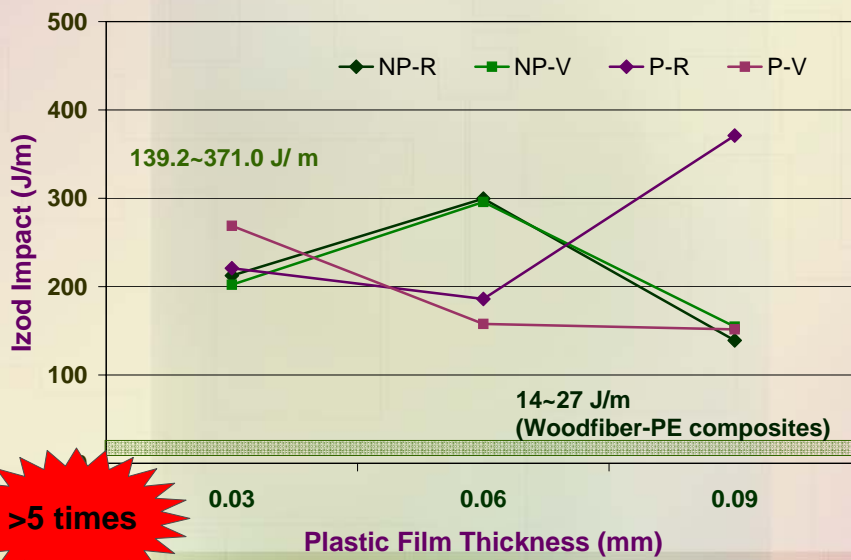
## Tensile Properties - MORT



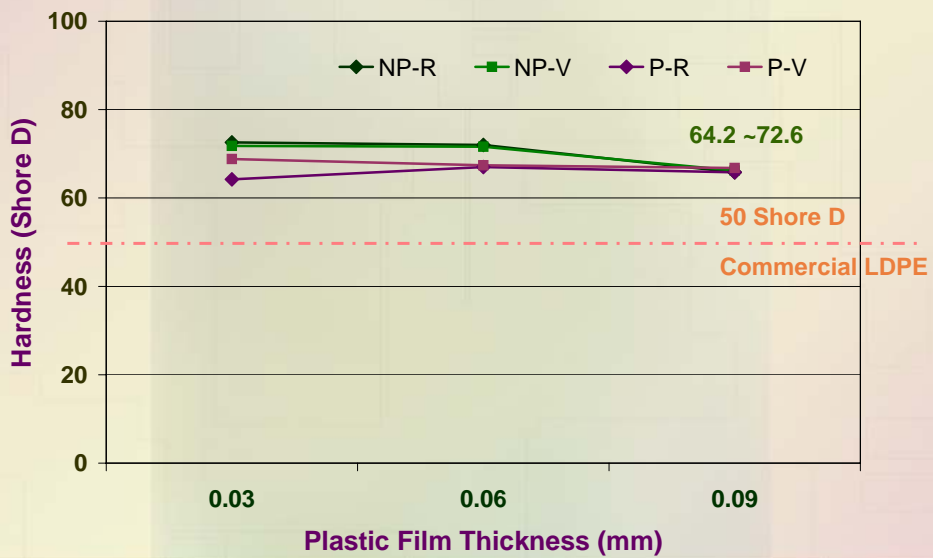
## Notched Izod Impact Properties



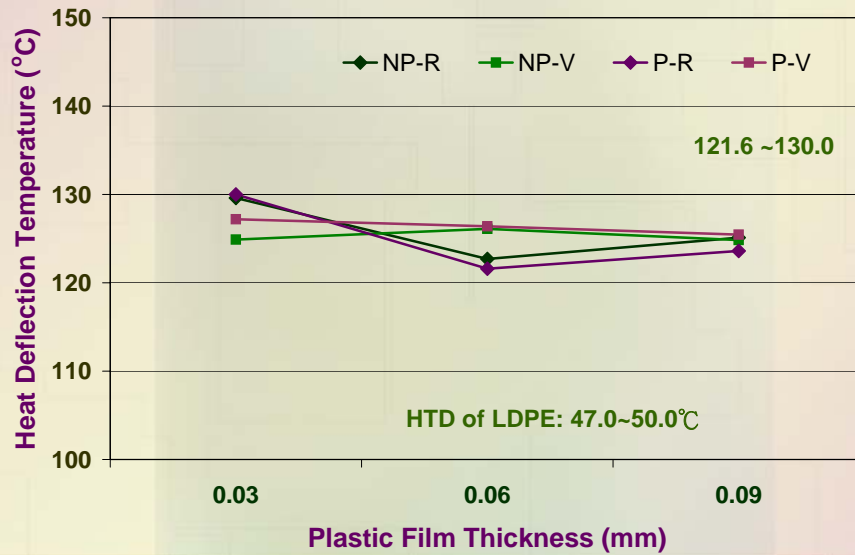
## Notched Izod Impact Properties



## Hardness



## Heat Deflection Temperature



## Limitations

- Size (length, width, thickness)
- Processability (higher stiffness, HDT)
- Anisotropy
- Durability unknown
- Applications

## Conclusion

- MORb, MOEb, MORt, and Izod of PPLs were better than reported WPCs.
- The PPLs prepared in this study exhibited 1.5-times the flexural strength and stiffness and 5-times the notched Izod impact strength over extruded woodflour-plastic composites.
- Except for tensile stiffness, all the other mechanical properties of the PPLs were affected by interactions among the 3 factors.

## Conclusion

- PPLs with the same plastic type tended to show similar trends in flexural properties, whereas PPLs with the same paper type tended to exhibit similar trends in tensile strength at break, Izod impact strength, and hardness.

## Conclusion

- These results indicate that PPLs may be a viable alternative method of paper recycling. However, further studies to address the long-term performance of PPLs under extreme conditions are recommended.
- Feasibility of developing PPL as a paper recycling alternative seems to be encouraging.

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Questions?