



Northeast (NEFU)



Material Science & Engineering College

2000 students (500 graduate student)

115 staffers

One first-degree national subject:

Forestry engineering

One key lab of Education Ministry :

Bio-based material science & technology



Speciality:

Wood science and engineering,

Forest products chemical process ,

Material chemical, Paper manufacturing

Furniture design and interior decoration

Vision expression

Agricultural Straw Reinforcing Polypropylene by Hot Pressing

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Content

- Back ground
- Prepare straw/HDPE composite by hot pressing
- Property test and results
- Conclusion

- **Straw resource**

700 M ton annually

- **Wood plastic composite (WPC)**



www.wpc.net.cn



www.gokart.net.cn

2004/07/30



Why do we use hot pressing method ?

- Agriculture straw is an abundant resource
- Thermo-degradation occurs during extrusion
- Present research :
 - Use straw in WPC industry by hot pressing

- **Advantages of hot pressing process**

Large size cellulosic raw materials

Large size board

Less thermo-degradation

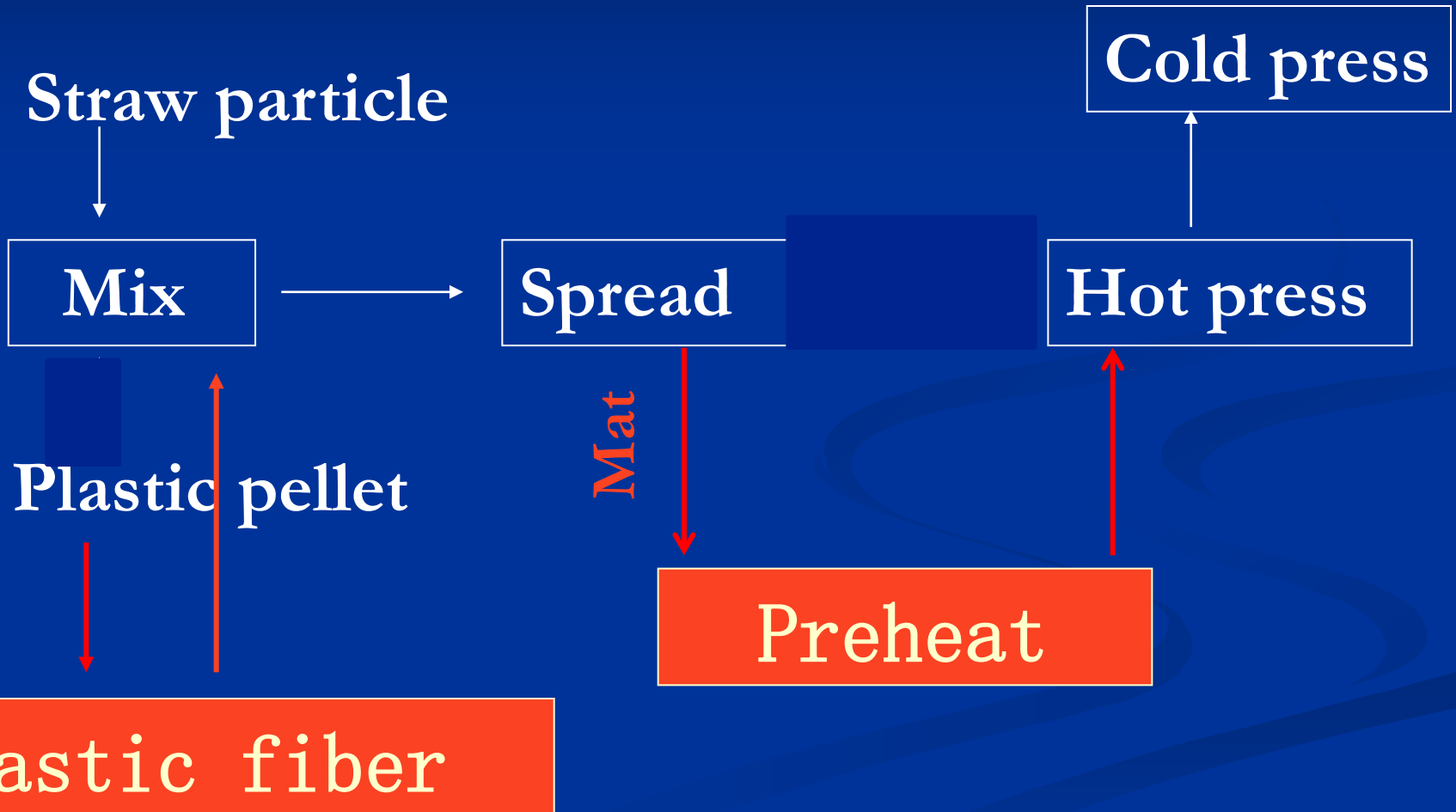
Problem in hot pressing method

- 1) Not completely melt
- 2) Not uniformly mixing

Key means

- 1) Ensure effective hot pressing time
- 2) get similar bulk density

1 prepare straw/HDPE composite by hot pressing



Advantages

- Uniformly mixing
- Elevate the temperature of mixture mat and shorten hot pressing time
- Evaporate moisture in straw

1.1

PE



- **Property test**

Bending strength (BS)

Modulus of elasticity (MOE).

Thickness swelling (TS).

Internal bonding strength (IB).

Table 1 Effects of straw particle size and **preheating treatment on the properties of straw/HDPE powder composite (16cm × 16cm × 0.9cm)**

Treatment	Straw size (mesh)	Density (g/cm ³)	BS (MPa)	MOE (GPa)	2 h TS (%)	24 h TS (%)
Without preheating	16 – 8	0.68 (0.021)	5.66 (0.411)	0.82 (0.069)	30 (2.471)	35 (3.999)
Preheating	16 – 8	0.69 (0.022)	7.44 (0.569)	1.11 (0.073)	20 (1.756)	22 (3.008)
	40–16	0.62 (0.025)	9.05 (0.845)	1.26 (0.096)	14 (1.850)	19.05 (0.845)



**Straw fiber/HDPE powder composite by hot pressing
(16 × 16 × 0.9 cm)**

1.2 Prepare straw/HDPE fiber composite



Spread, preheat, hot press, and cold press



2 Properties of straw/HDPE composite

2.1 Comparing straw /HDPE powder and straw/HDPE fiber composite

2.1 Properties of straw/HDPE fiber and straw/PP fiber composites

2.1 Comparing straw /HDPE powder and straw/HDPE fiber composite

Table2 Effect of HDPE shape on the properties of straw/HDPE composite

HDPE shape	Density (g/cm ³)	BS (MPa)	MOE (GPa)	2 h TS (%)	24 h TS (%)
Powder	0.62 (0.025)	9.05 (0.845)	1.26 (0.096)	14 (1.850)	19.05 (0.845)
Fiber	0.55 (0.029)	11.36 (1.058)	1.12 (0.097)	10 (0.102)	15 (1.397)

2.2 Properties of straw/HDPE fiber composites

Table 3 Properties of wheat straw/HDPE fiber composite **with and without** coupling agent (16cm × 16cm × 0.9cm)

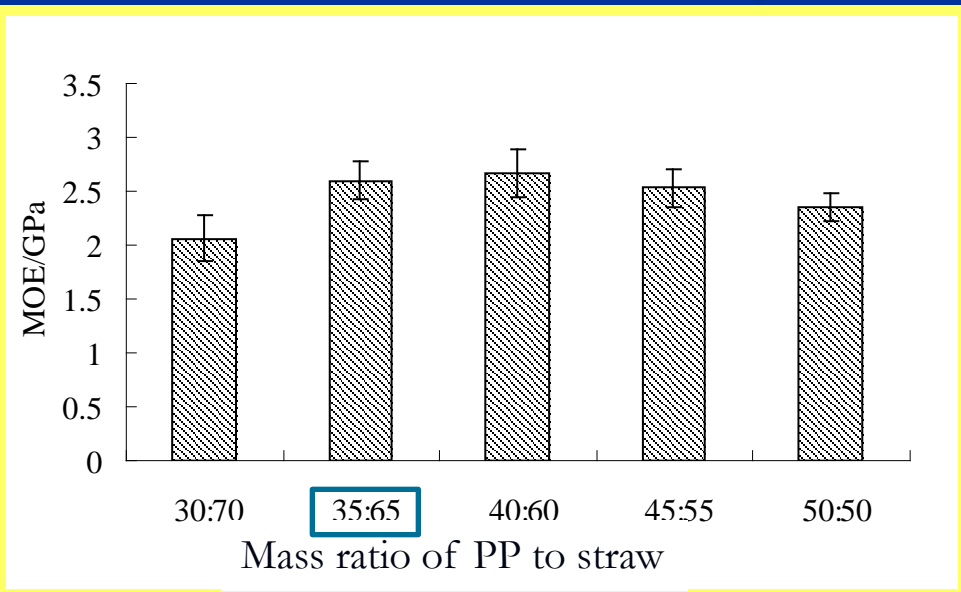
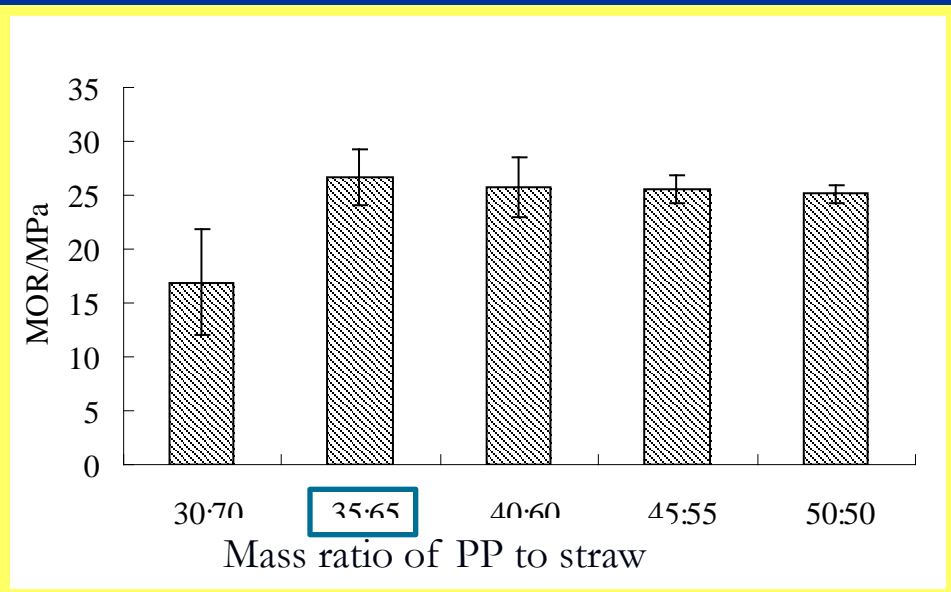
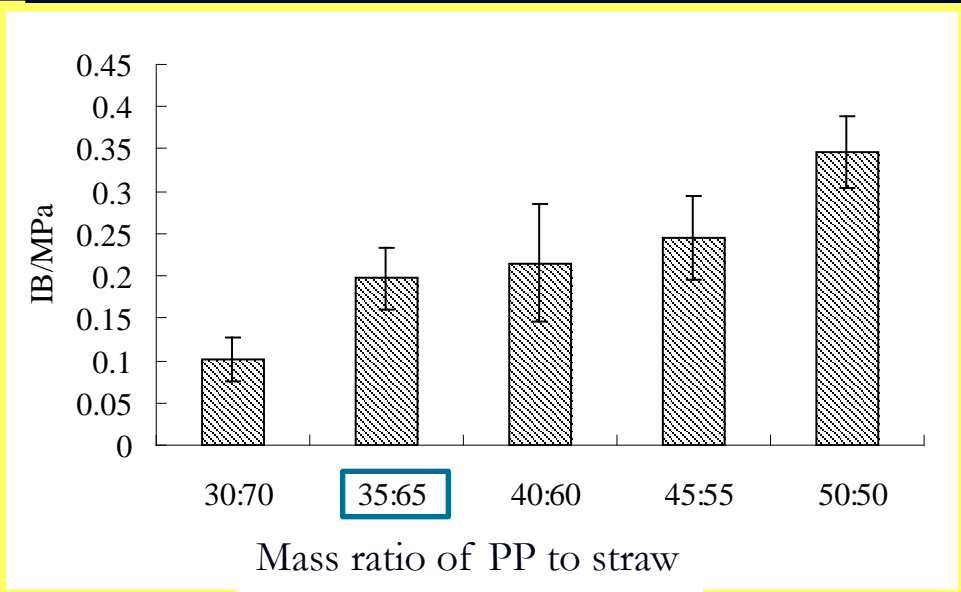
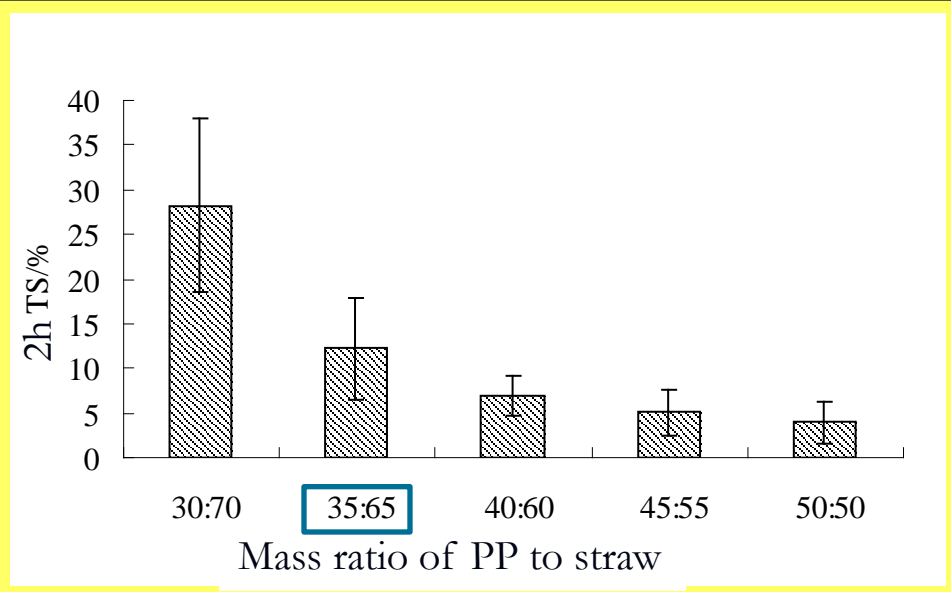
	Density (g/cm ³)	BS (MPa)	MOE (GPa)	2 h TS (%)	24 h TS (%)	IB (MPa)
Without coupling agent	0.55 (0.029)	11.36 (1.058)	1.12 (0.097)	10 0.102)	15 1.397)	0.24 (0.020)
Containing MAPE	0.59 (0.022)	17.61 (1.627)	1.23 (0.198)	9 (0.906)	10 (1.000)	0.32 (0.017)

Table 4 Properties of wheat straw/**HDPE fiber** and straw/**PP fiber** composites (35 cm × 35 cm × 1 cm)

	MAPE (%)	Density (g/cm ³)	BS (MPa)	MOE (GPa)	IB (MPa)	2 h TS (%)	24 h TS (%)
Straw: HDPE 60:40	4	0.70 (0.017)	17.00 (1.197)	1.57 (0.152)	0.55 (0.028)		9.00 (0.899)
Straw:PP 60:40	4	0.73	36.76	2.92	0.77	1.77	

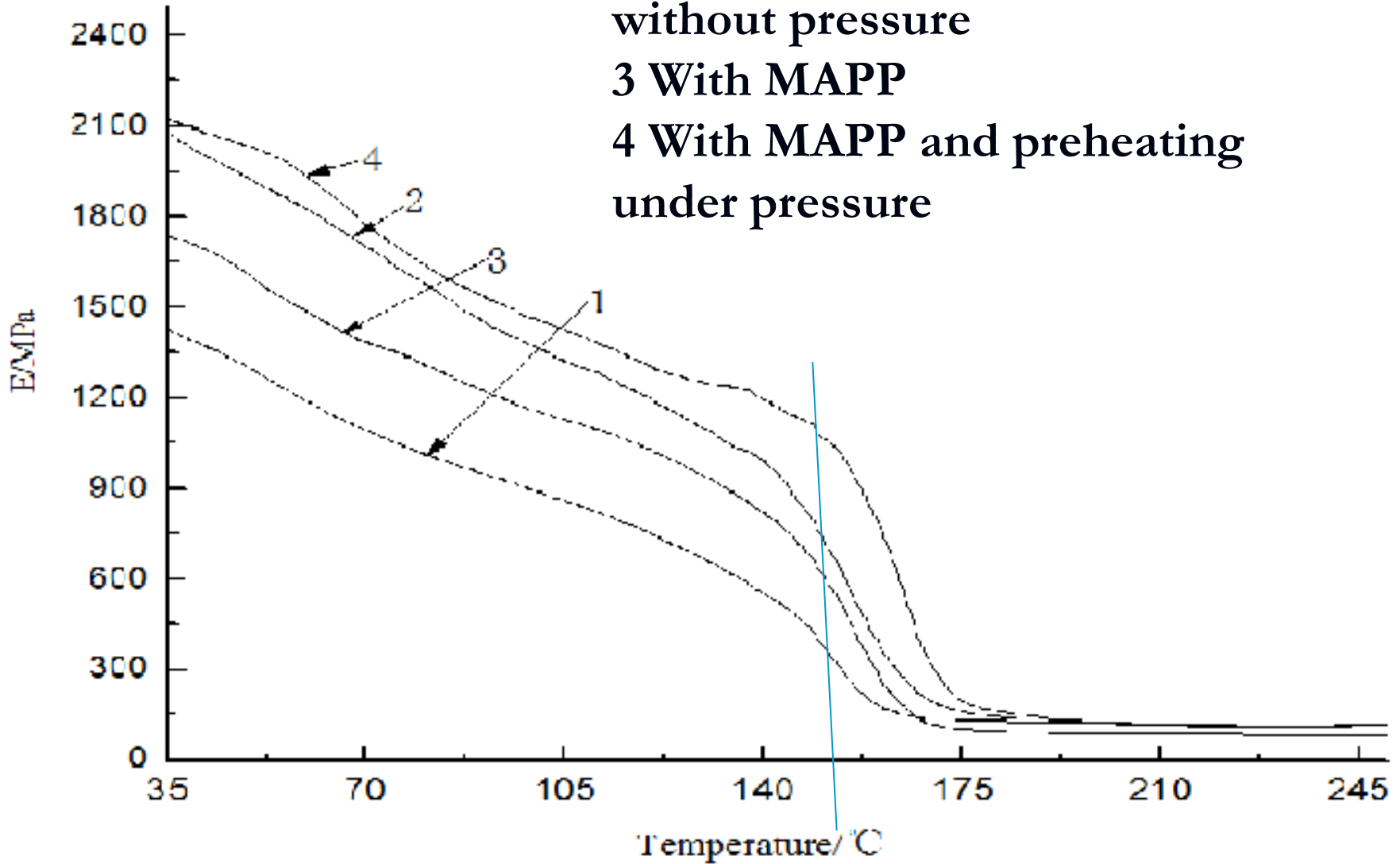
Table 5 Ratio of PP to straw

No.	Length of PP fiber (cm)	PP: straw	Mesh of straw particle
1		30:70	
2		35:65	
3		40:60	
4	3-5	45:55	20-40
5		50:50	



Effects of the ratio of PP to straw on the properties of straw/PP fiber composite

- 1 Without MAPP and preheating
- 2 With MAPP and preheating without pressure
- 3 With MAPP
- 4 With MAPP and preheating under pressure

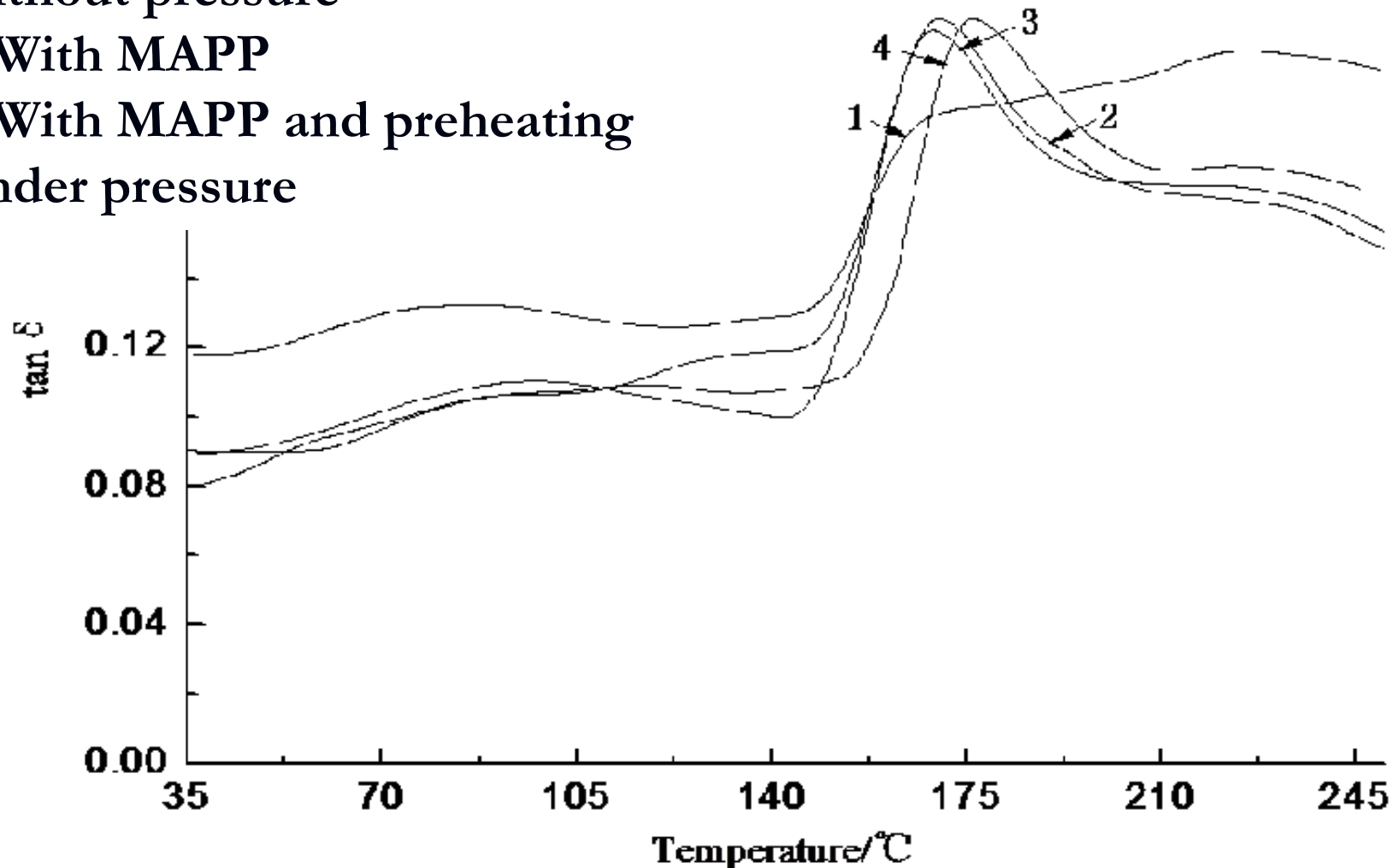


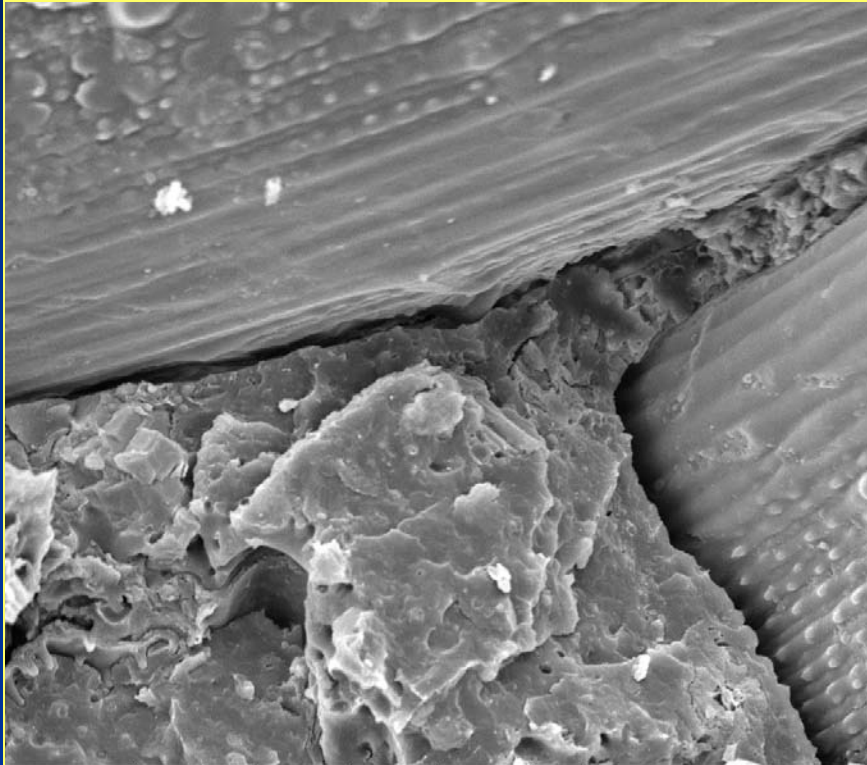
1 Without MAPP and preheating

2 With MAPP and preheating
without pressure

3 With MAPP

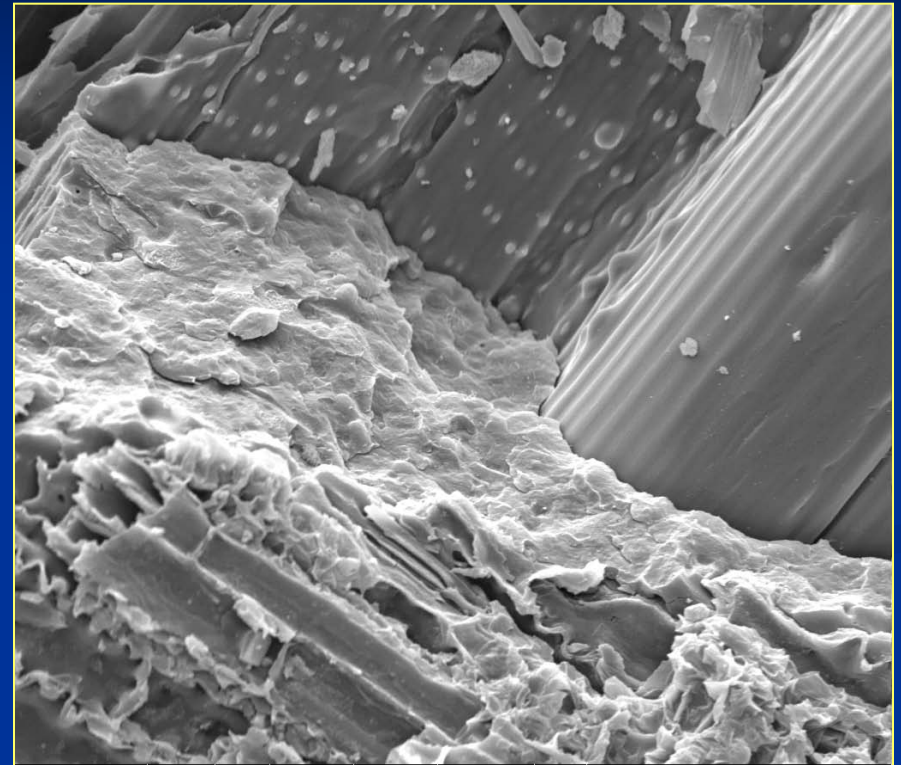
4 With MAPP and preheating
under pressure





9/13/2010	Mag	Spot	WD	HV	Pressure	Det	—20.0µm—	
10:28:08 AM	1000x	5.5	11.3 mm	12.5 kV	---	ETD	test	

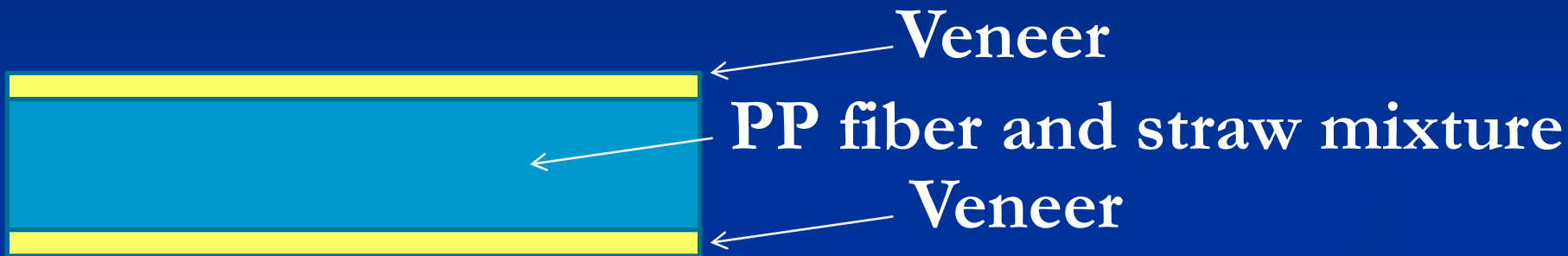
Preheat without pressure



9/13/2010	Mag	Spot	WD	HV	Pressure	Det	—20.0µm—	
11:09:07 AM	1000x	5.5	7.4 mm	12.5 kV	---	ETD	test	

preheat under pressure

3 Veneer covered straw/PP fiber composite



Preheat

Method A

Hot press

Cold press

PP fiber and straw mixture



Preheat

Hot press

Cold press



Cold press

Hot press

Method B



Veneer

Veneer

Straw/PP composite panel



- **Property test**

Surface bonding strength

surface wettability



Sample treatment :

Boiling/4h,

Drying at $63 \pm 3^{\circ}\text{C}/20\text{h}$,

Boiling/4h,

Drying at $63 \pm 3^{\circ}\text{C}/3\text{h}$

Sample size: 75mm × 75mm

Method B



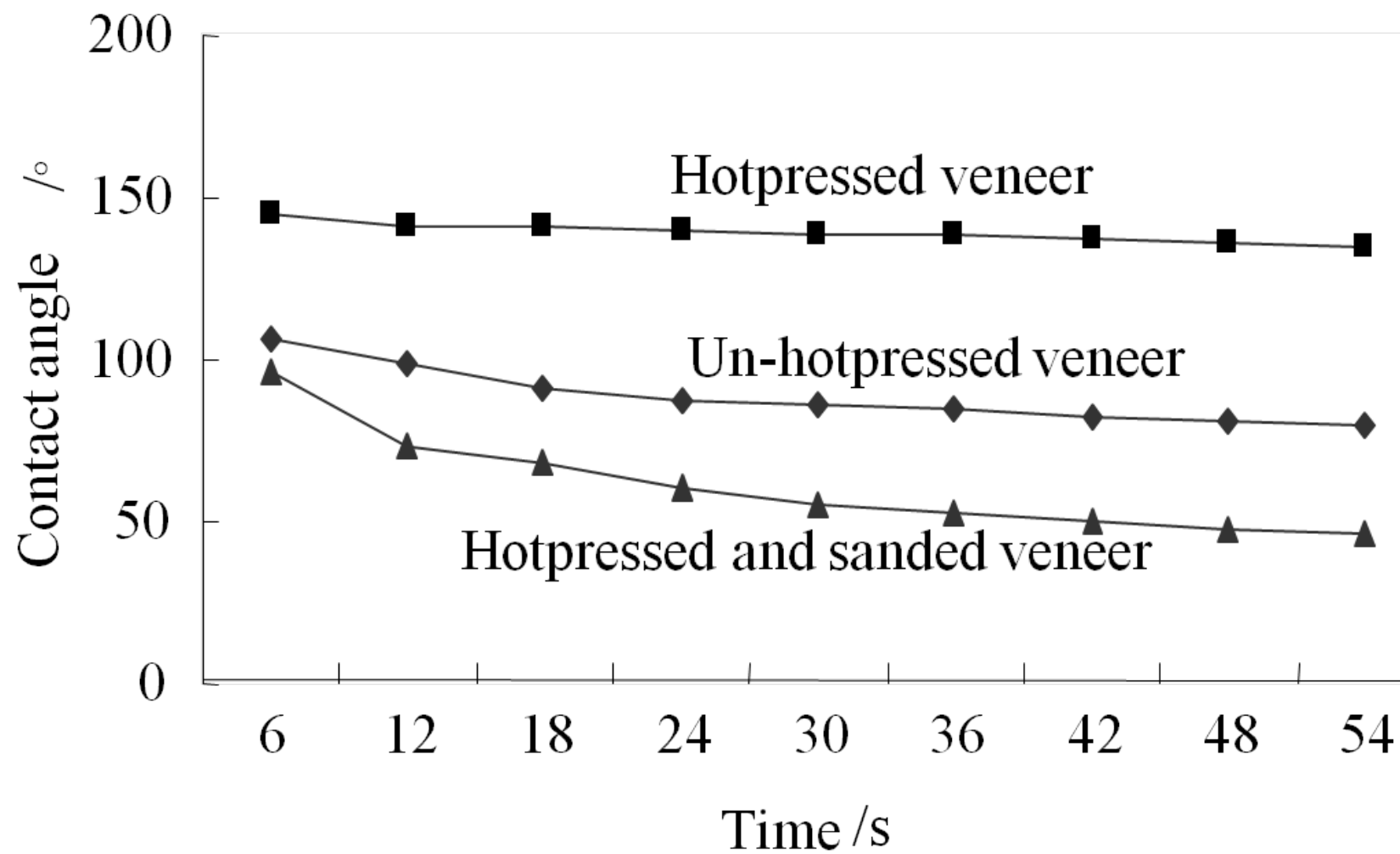
Method A



Table Separation between surface veneer and composite panel

Separation after boiling (mm)

Overlaying Method	a	b	c	d	e	f	Total
Method A-- Preheating and hot pressing together	0	0	0	0	0	0	0
Method B -- Overlaid on straw/PP composite panel	1	2	1	1	2	2	9



Conclusion

- Preheating the mat before hot pressing can provide better properties of straw reinforcing thermoplastic composite.
- Thermoplastic in fiber shape mixes more uniformly with straw particles than in powder shape and improves the properties of the.
- Veneer could be overlaid directly on the surface of straw/PP fiber composite by the aid of PP accumulated on the surface. No other adhesive was used. And the stability of surface veneer almost was not effected.

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Thank you