SWST/ICBR International Convention

Effects of In Situ Deposited Calcium Carbonate Nanoparticles on Tensile Performance of Single Bamboo Fibers and Their Composites

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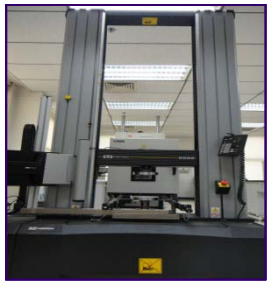
SFA Key Open Laboratory of Bamboo and Rattan Science and Technology



ICBR Key Laboratory mainly engages itself in the studies on micro- and macro- scale structure , properties characteristics and utilizations (like bio-engineering, bio-energy) of bamboo and rattan.

Anhui Taiping

Hainan Sanya

Experimental Stations

Faculty

Projects and Cooperations

Ministry of Science and Technology(MS&T) :

11th and 12th Five-Year National S&T Support Programs, Agricultural S&T achievements for capital projects.

State Forestry Administration(SFA):

“948”Project, S&T promotion project, and Forestry engineering project.

Research fields

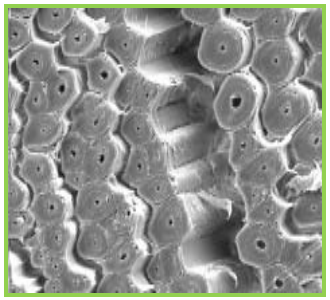
Properties and Ulitizations of Bamboo fibers

Bamboo Fibers

Bamboo Fiber Composites

Parallel Bamboo Scramber Lumber

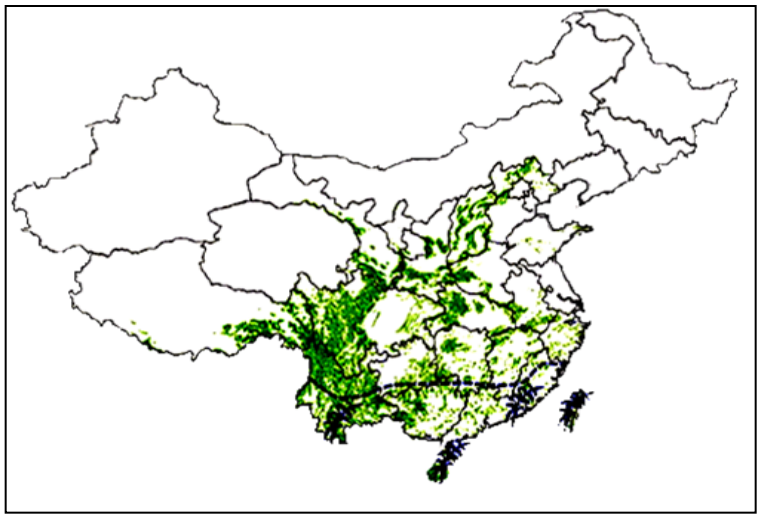
Bamboo Texitles



Outline

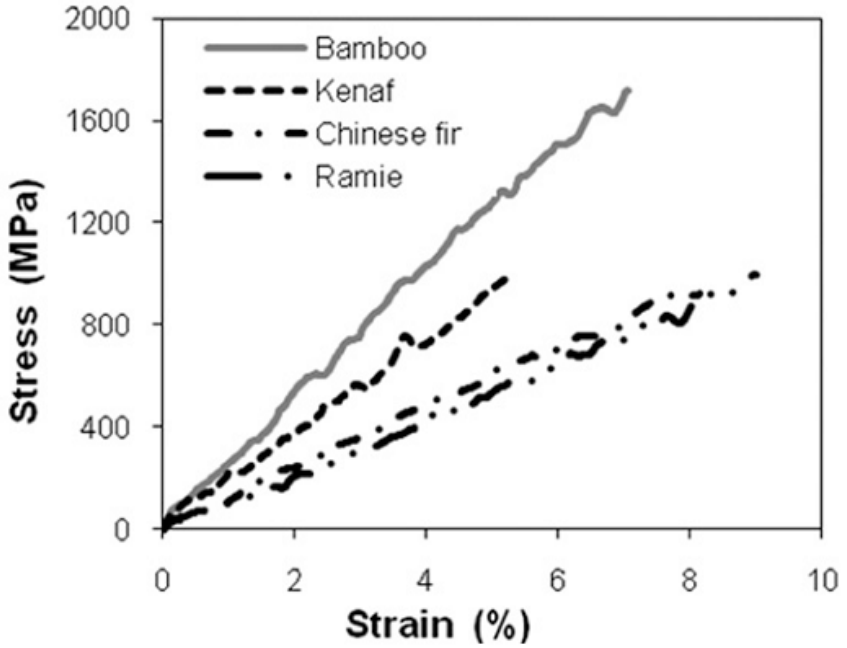
- Background
- In Situ Deposited $CaCO_3$ Nanoparticles Treatment
- Properties of modified bamboo fibers and their reinforced PP composites
- Summary

1 Background



5.38 million ha

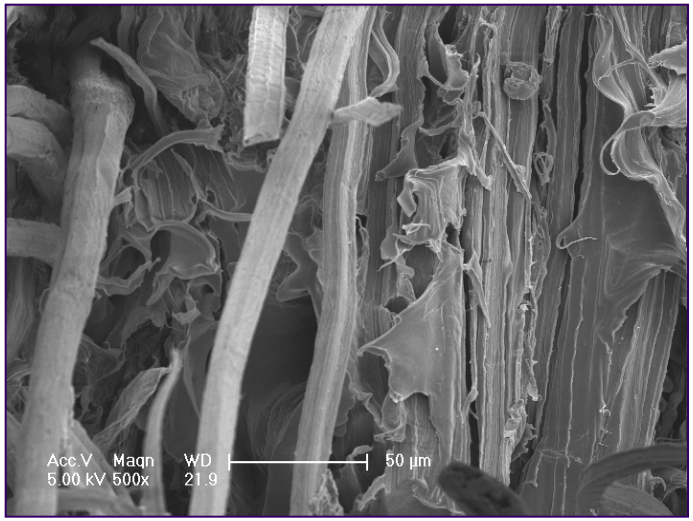
82.1billion yuan



- bamboo fibers were much stronger and stiffer than other fibers tested, indicating that bamboo fibers have potential in high-performance fiber reinforced composites.

(WANG Ge, etc. Wood and Fiber Science , 43(4), 2011)

Bamboo fiber reinforced plastic composites



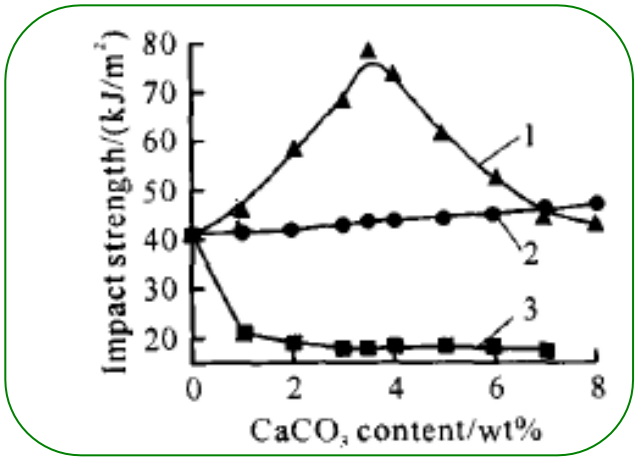
bad interfacial adhesion of hydrophilic cellulosic fibers and hydrophobic polymer matrix.

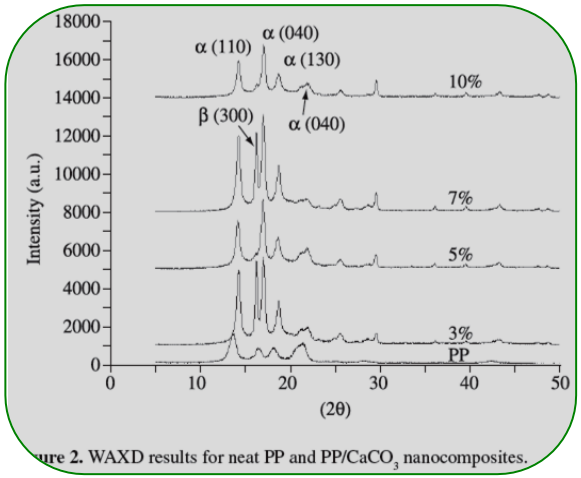
MODIFICATIONS

- Heat treatment
- Alkali treatment
- Plasma Treatments
- Coupling agent
- Micro-fibers
- nanoparticles

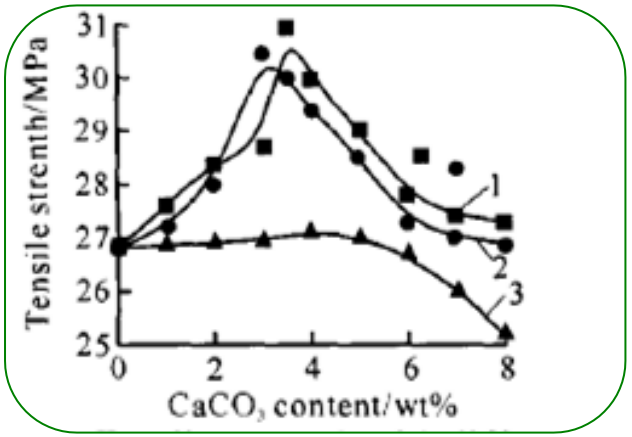
$CaCO_3$ nanoparticles

- Easily acquired
- Low cost
- Nontoxic
- High specific surface area





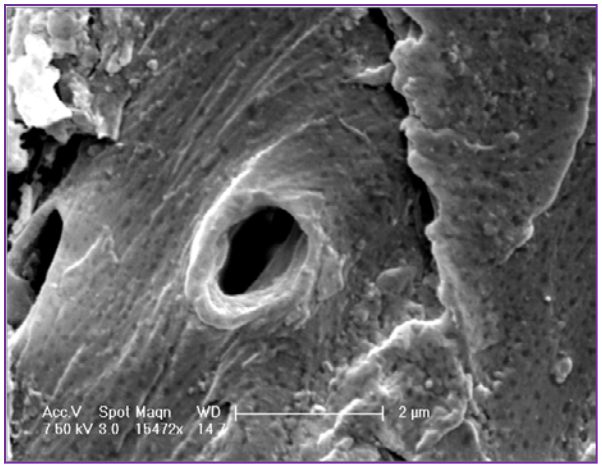
ure 2. WAXD results for neat PP and PP/$CaCO_3$ nanocomposites.

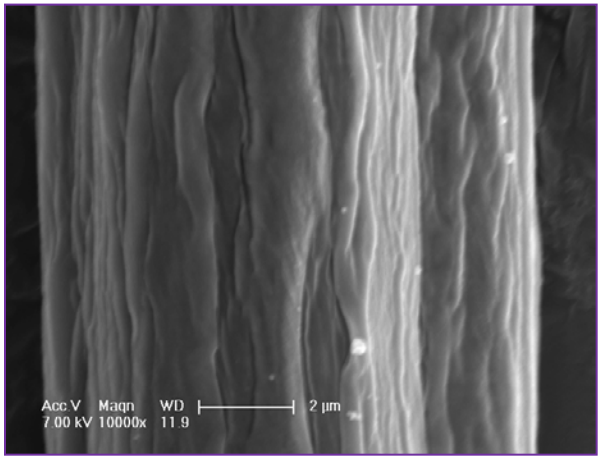


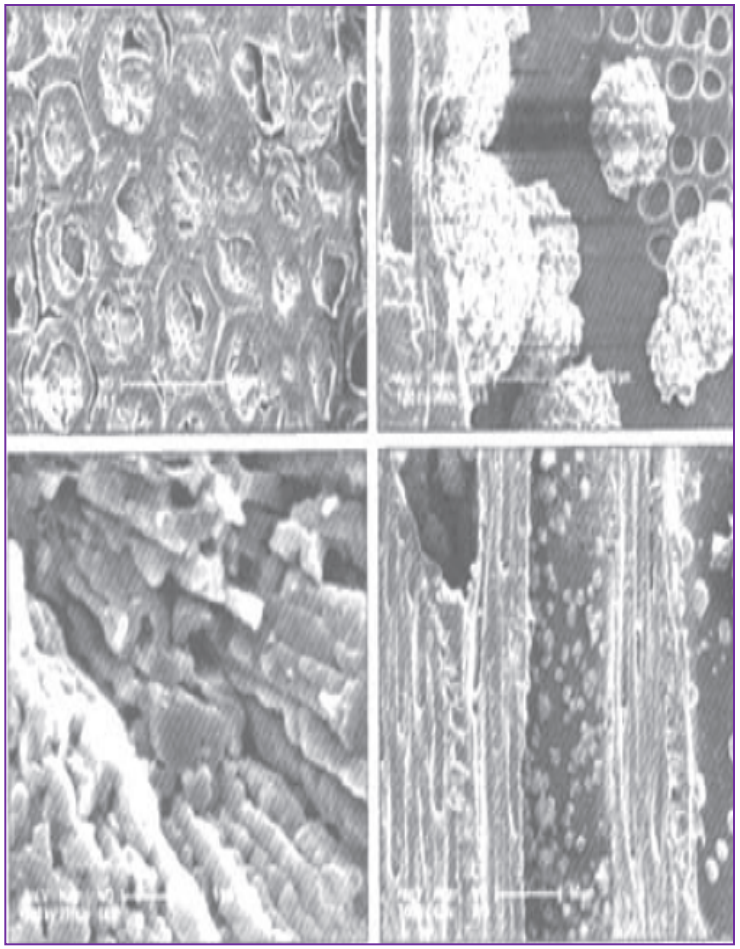
$CaCO_3$ nanoparticles ' effect on crystalline orientation of polymer

$CaCO_3$ nanoparticles ' effects on mechanical properties of composites

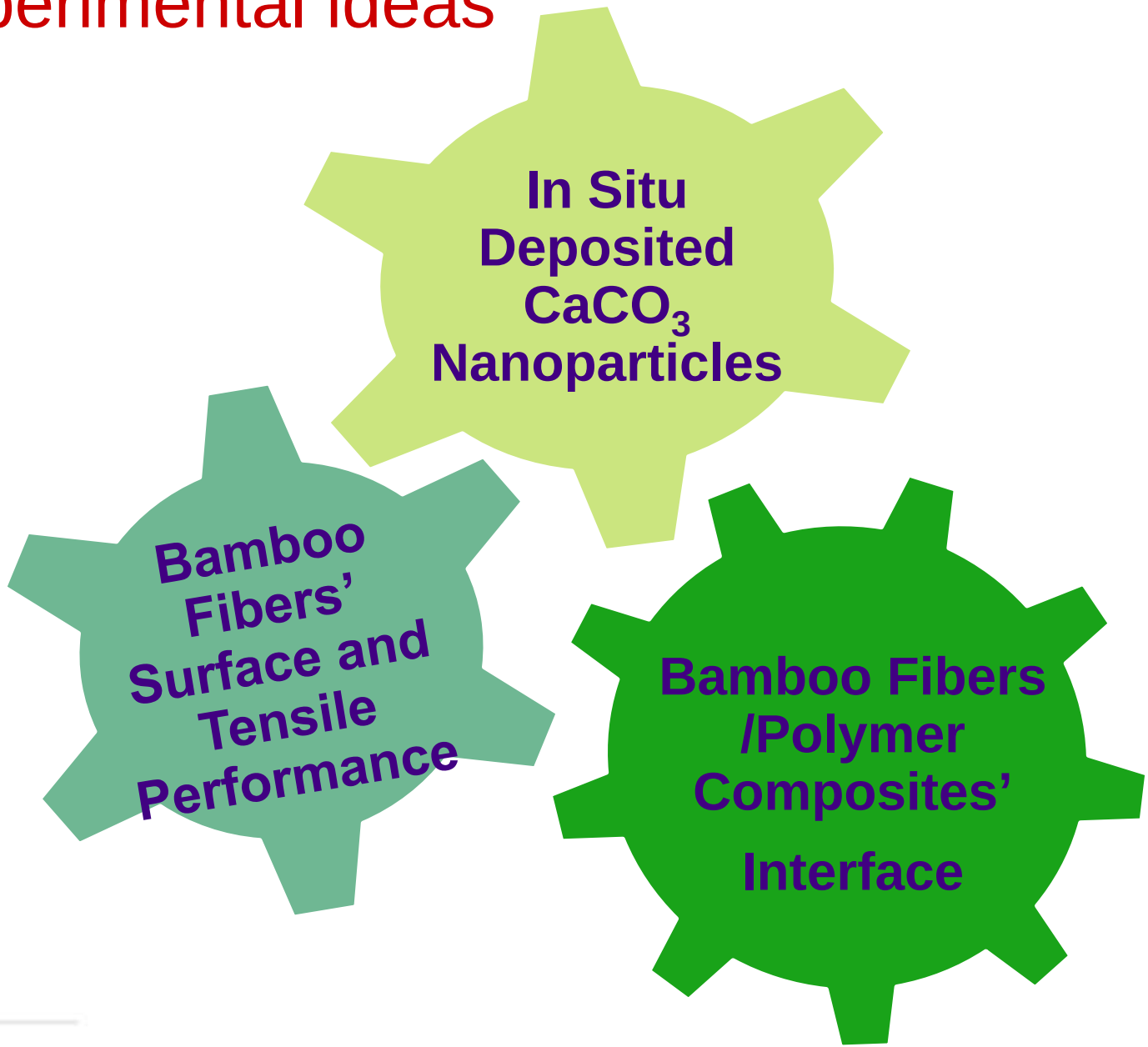
Natural Fibers as $CaCO_3$ Reacting Place





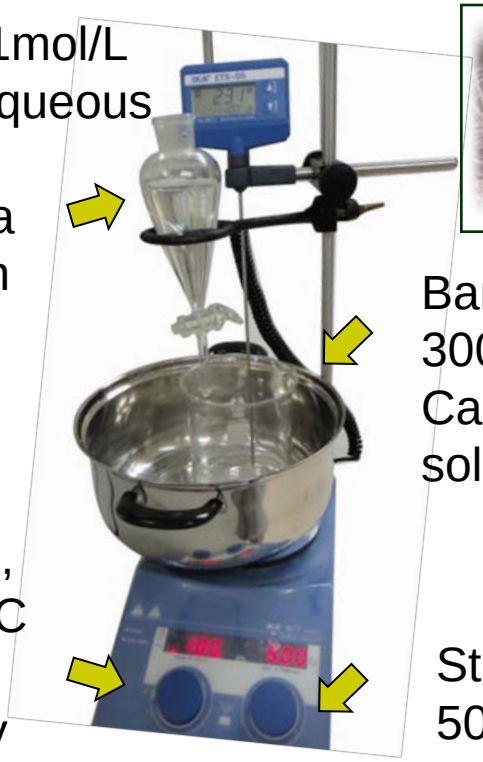


Experimental ideas



2 In Situ Deposited $CaCO_3$ Nanoparticles Treatment

300mL 0.1mol/L Na_2CO_3 aqueous solution
EDTA-2Na
25 mL/min



Bamboo fibers and 300mL 0.1 mol/L $CaCl_2$ aqueous solution(1:50 g/mL)

5°C, 15°C, 25°C, 45°C and 65°C separately

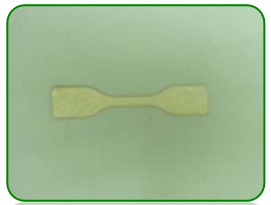
Stirring at 500rpm

Magnetic blender

$$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$$

Fiber Handsheets : PP (1:3,g)

180°C, 2MPa , 2min



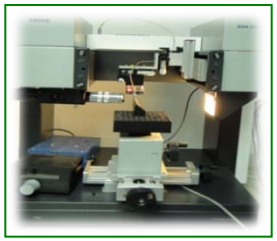
Tensile Test Sample
GB1040.3-2006-T

3 Properties of modified bamboo fibers and their reinforced PP composites

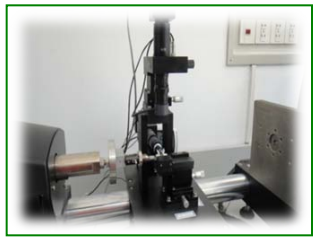
- Surface morphology of fibers
- $CaCO_3$ loading percentages
- Static contact angles of fibers
- Tensile performance of fibers
- Tensile performance of fibers /PP composites

FEI FESEM XL30

Carbolite Furnace

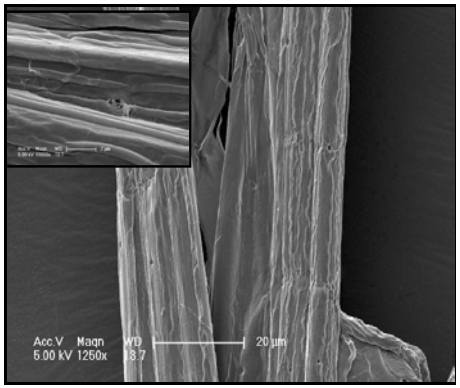


Kruss DSA100

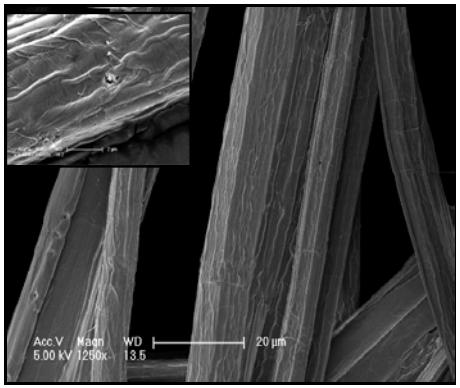


Instron 5848 Microtester

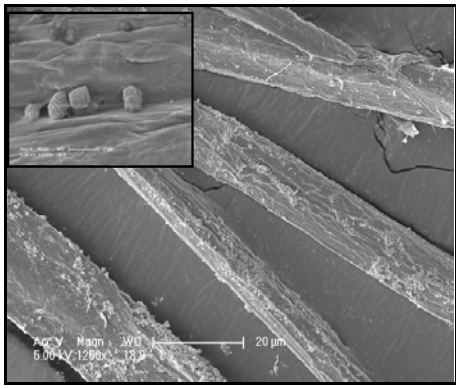
Surface morphology of fibers



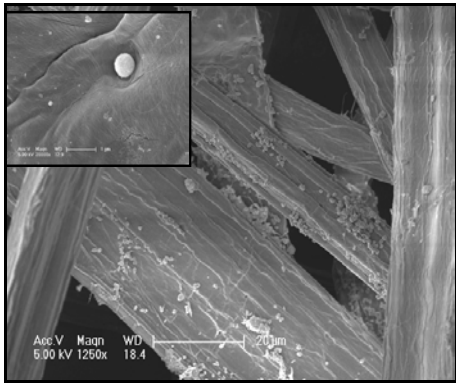
（a）The untreated



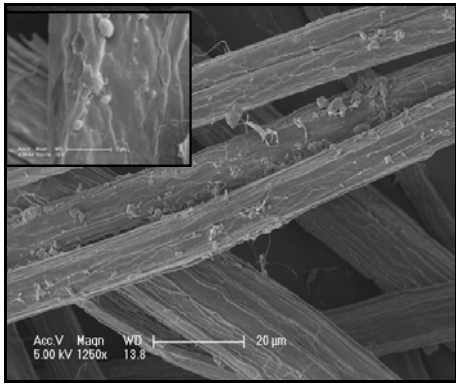
（b）5℃



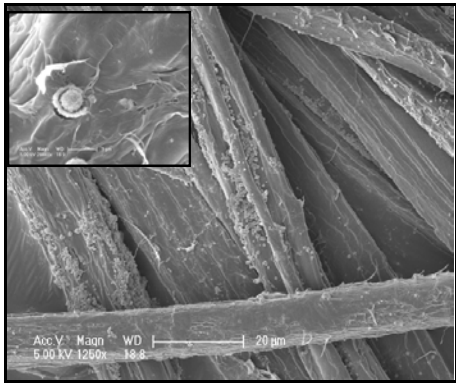
（c）15℃



（d）25℃



（e）45℃



（f）65℃

$CaCO_3$ Precipitation and Static Contact Angles of Bamboo Fibers

The Treated Conditions （° C）	$CaCO_3$ adsorbance （%）, N=2	Static Contact Angle （° ）, N=8		
		The Average	The Minimum	The Maxmum
The untreated	-	65.75	63.1	69.1
5	1.01	68.07	65.6	72.0
15	1.57	69.63	66.9	72.6
25	2.34	70.91	68.1	72.4
45	1.49	68.91	64.4	73.5
65	1.61	69.56	66.6	75.2

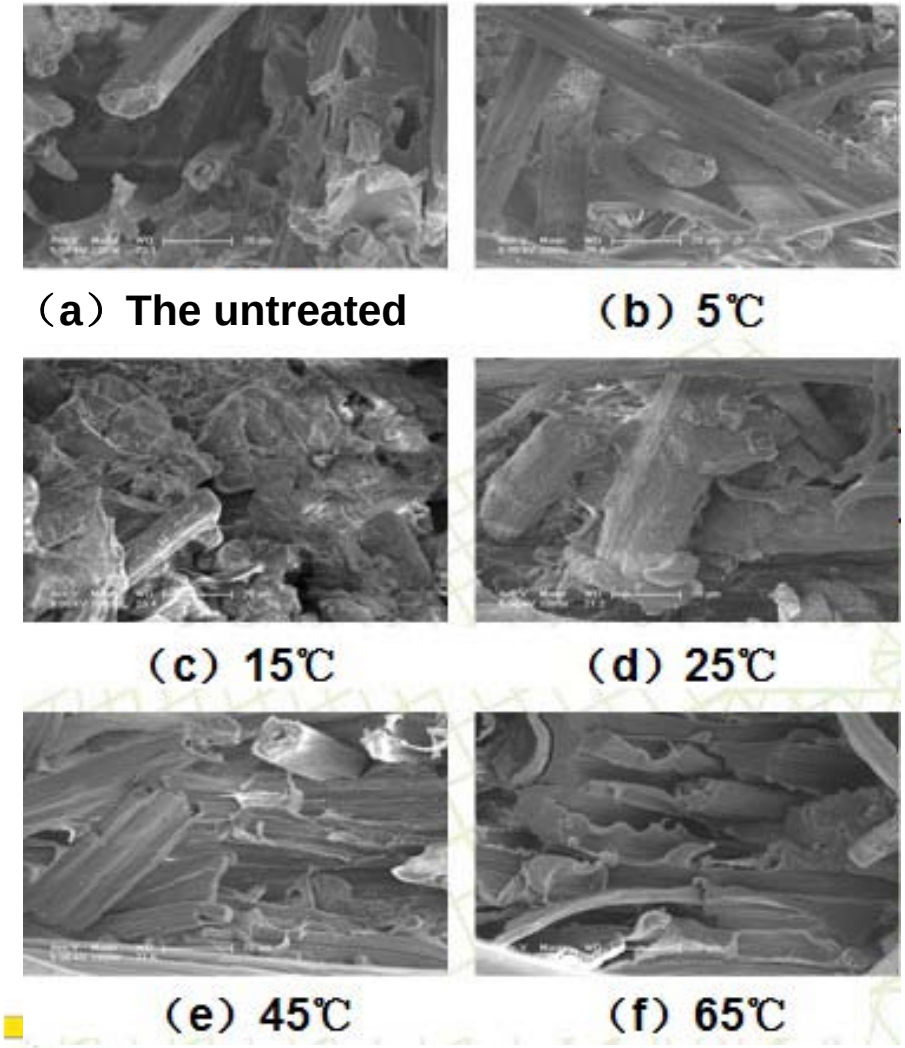
The coating of $CaCO_3$ nanoparticles may result in a smoother surface and reduced hydrophilic groups.

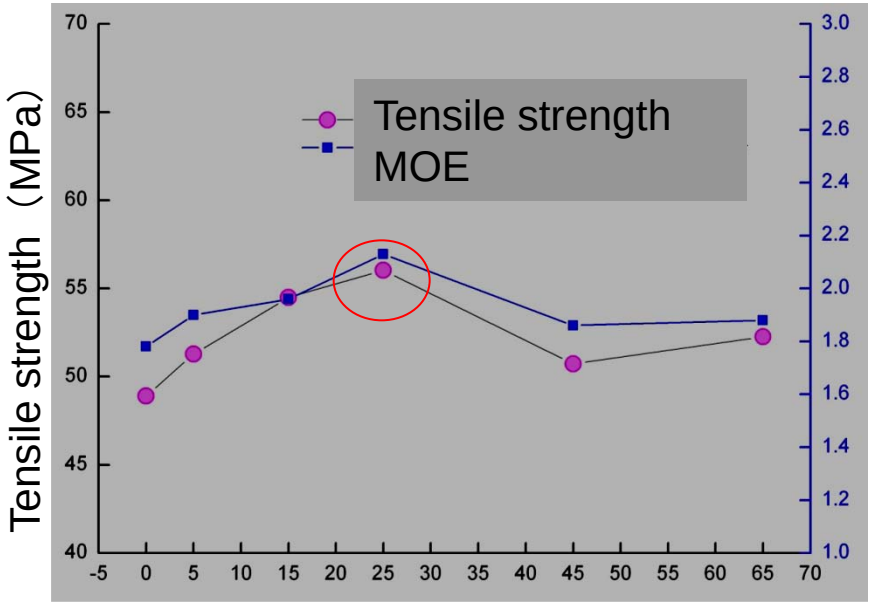
Tensile performance of fibers

Samples （° C）	Tensile strength （MPa）	MOE （GPa）	Elongation （%）
The untreated	1035.87	27.36	4.21
5	1136.64	29.80	4.09
15	1237.7	30.70	4.33
25	1383.99 *	36.30 *	3.89
45	1176.71	31.50	3.97
65	1167.18	29.43	4.34

* was significantly different at α= 0.05 according to results of multiple comparison with Fisher’s Least Square method.

Tensile performance of fibers /PP composites





The treated conditions（°C）

The Untreated

4 Summary

- $CaCO_3$ nanoparticles and submicron particles in situ grew into micropores of bamboo fibers.

- $CaCO_3$ nanoparticles contributed to the progress in wetting and tensile performance of bamboo fibers and the composites' interface.

- Optimal temperature was 25°C, the $CaCO_3$ adsorbance and contact angle of fibers were 2.34%, 70.9°.Tensile strength and MOE of modified fibers and their composites, (30.50%, 32.71%) and (14.6%, 19.6%) higher than those of the unteated respectively.

Acknowledgements

I would like to thank National Natural and Science Foundation of China (31170525) for financial support of this study.

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Thanks for your attention!

QUESTIONS?