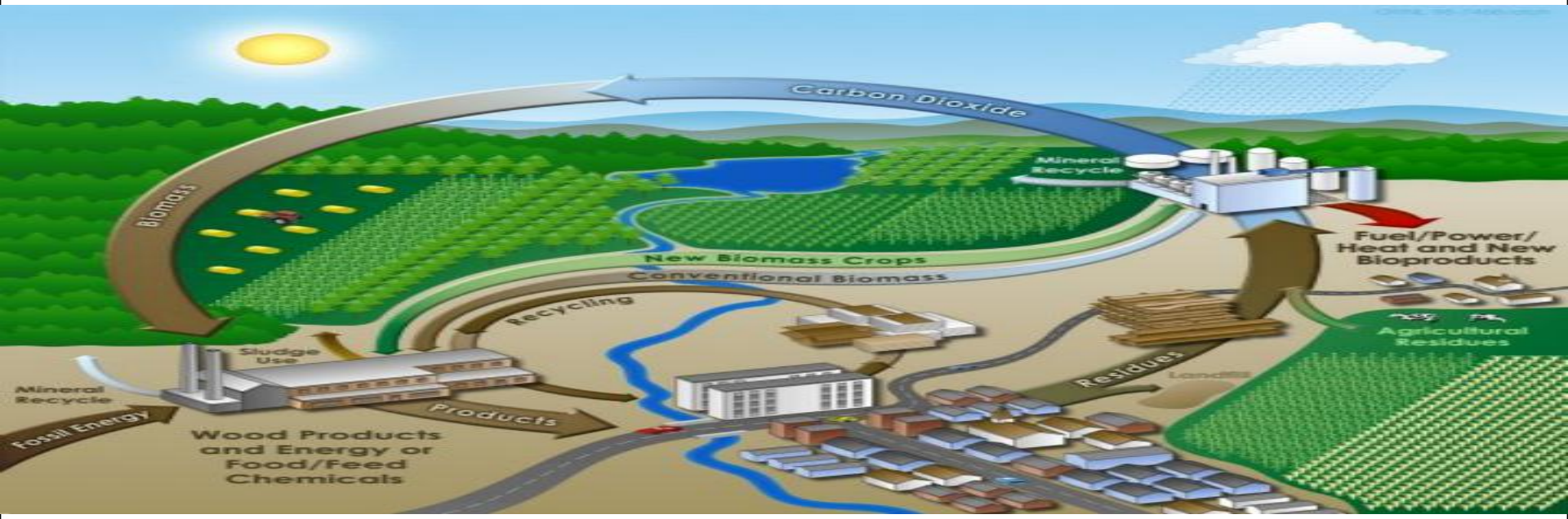
Development and Prospect of Forest Biomass-based Energy and Materials in China



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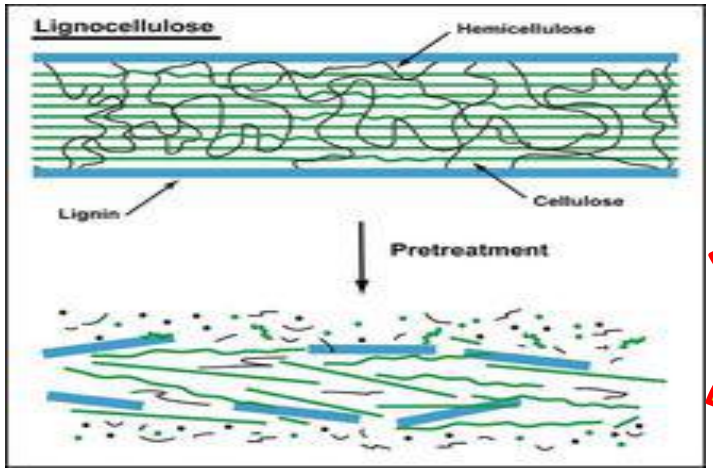
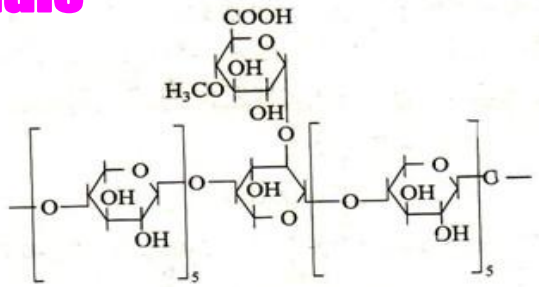
南京林業大學
Nanjing Forestry University

Researches and Development on Agro-forest Biomass Energy and Materials in China

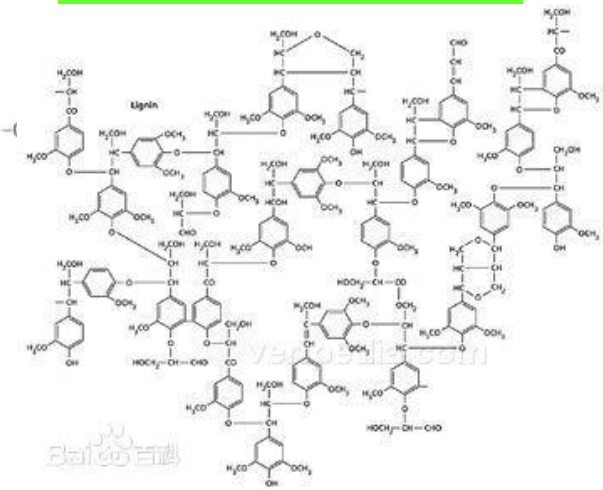
1. Cellulosic Fuel Ethanol

1.1 Pretreatment of Lignocellulosic Materials

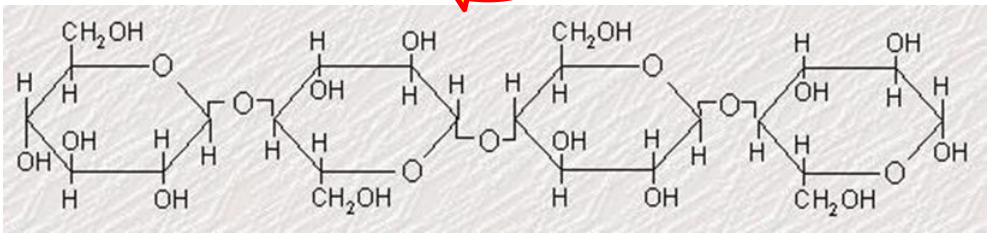




Hemicellulose



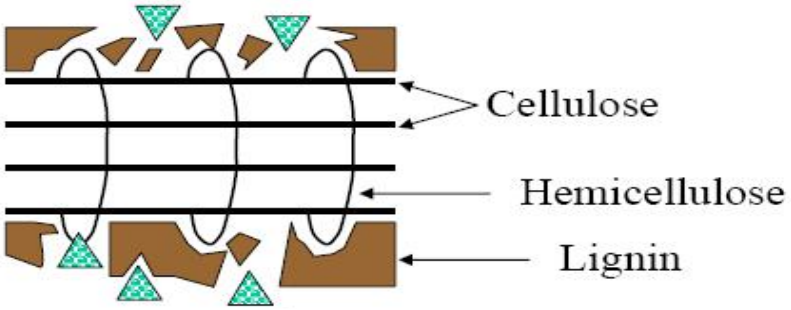
Lignin

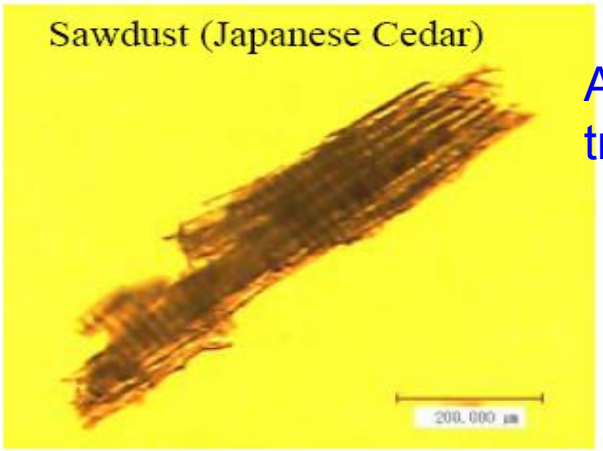


Cellulose

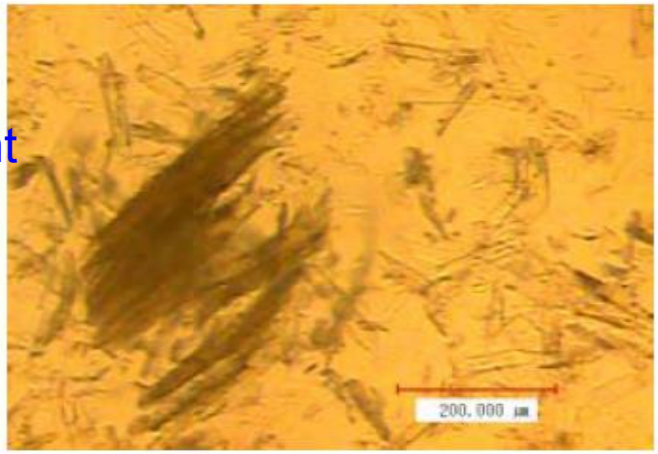
Pretreatment of Lignocellulosic Materials by Steam Explosion

Disintegration of Wood by steam explosion

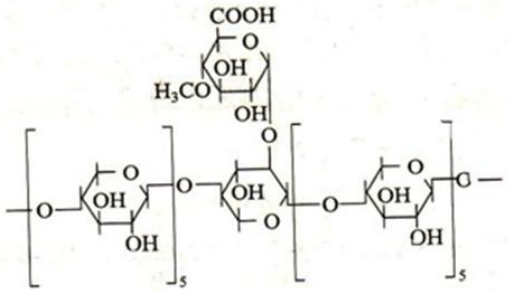




After treatment



1.2 Hydrolysis and Fermentation with Temperature Gradient Method

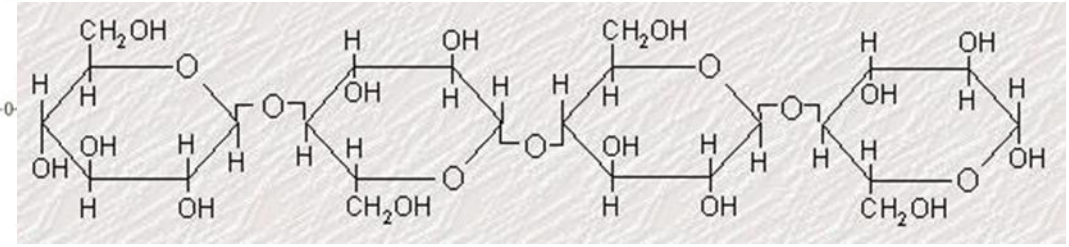


Hemicellulose

Hydrolysis

70-80 ℃

C5, C6 Sugars

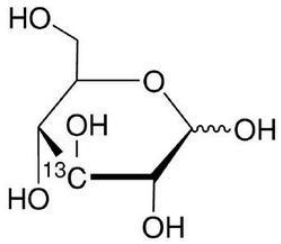


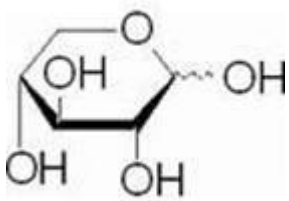
Cellulose

Hydrolysis

55-65 ℃

Glucose





Sugars

Fermentation

35-45 ℃

Fuels
Chemicals

1.3 Bioethanol Industry

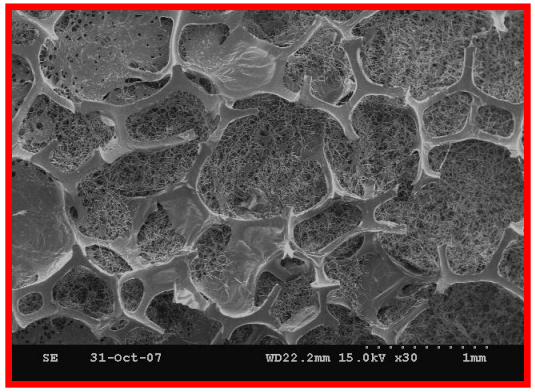
There are 4 major companies for bioethanol production in China, and total production of bioethanol is 2.1 million tons per year.

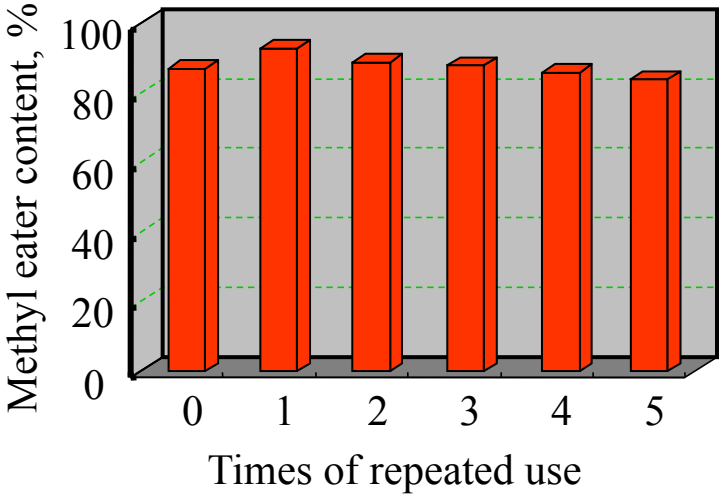
Henan Tianguan Group, the biggest company for bioethanol production in China. Bioethanol capacity of 800000 t/a, and cellulosic ethanol capacity 50000 t/a.

2. Biodiesel

Transesterification of Woody Plant Oil and Waste Oil over Catalysts

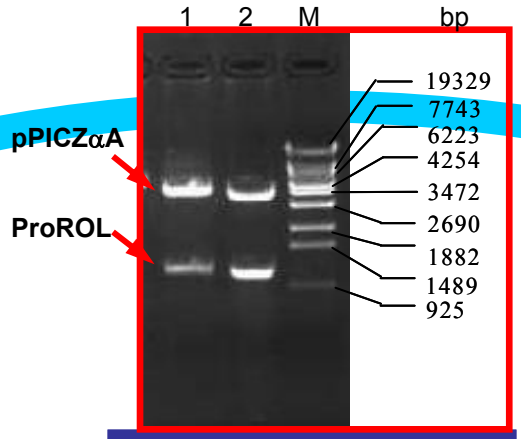
▲ Immobilized Whole Cells



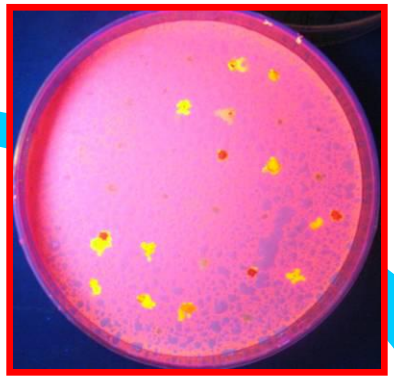


▲ Construction of Genetic Engineering Strain of Lipase

Rhizopus oryzae mycelia

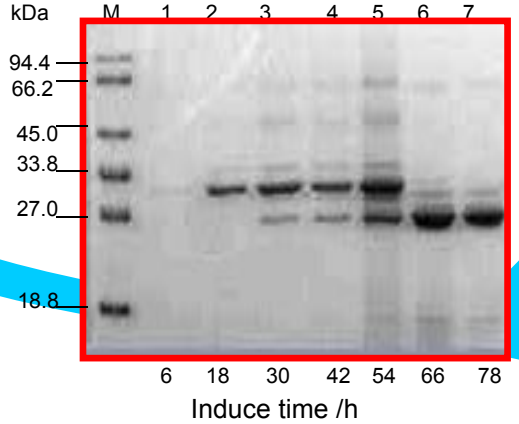


Cloning of ROL



Expression of ROL in *Pichia pastoris*

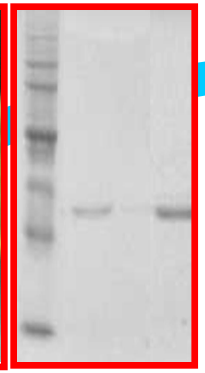
The activity of recombinant ROL was above 91 U/mL, which is about 6 times as that of the original strain .



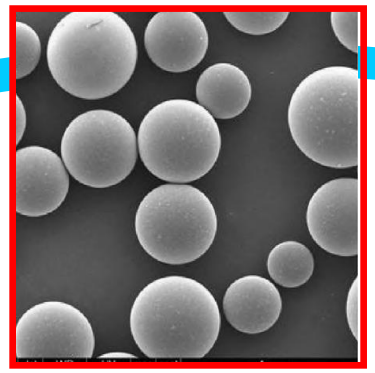
The activity of recombinant ROL was above 2000 U/mL.

High density cultivation of the genetic strain cells

▲ Immobilized Lipase

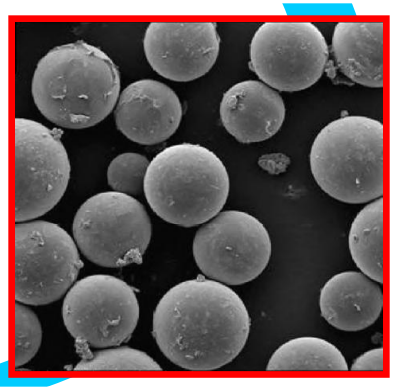


Recombinant ROL



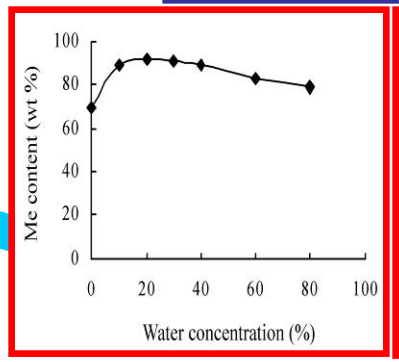
Amberlite IRA-93 resin

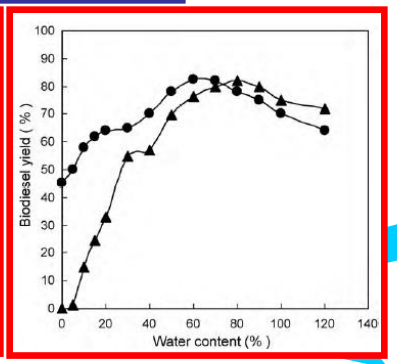
SEM micrographs



Immobilized recombinant ROL

The yield of ME from the Pistacia chinensis bge seed oil reach 94%.

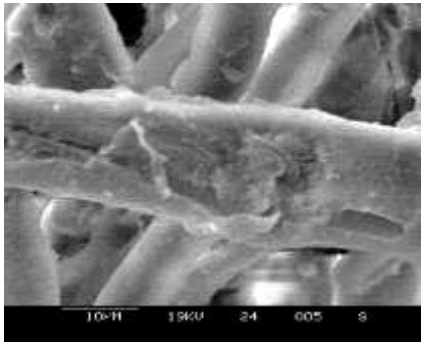


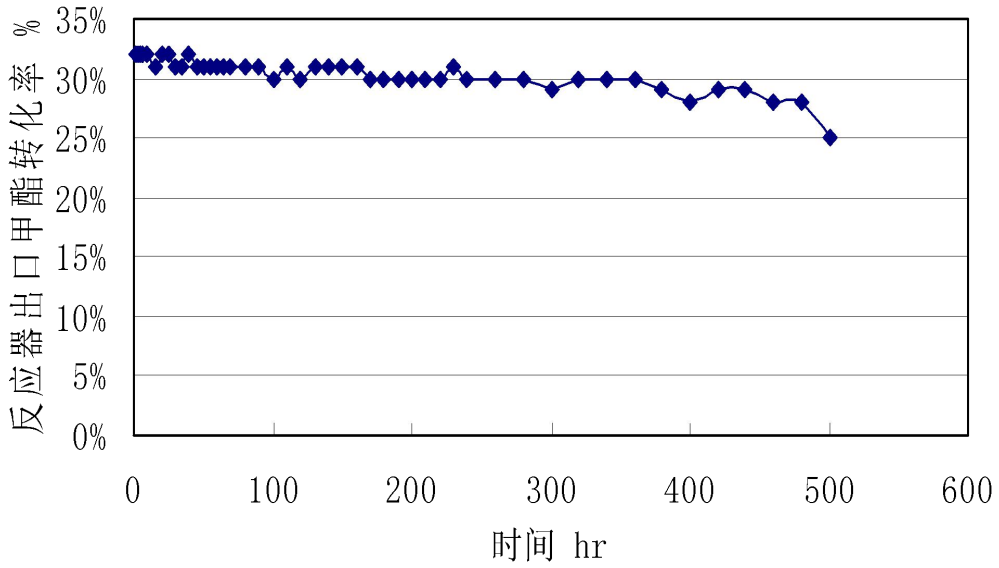


Transestification

●Immobilized lipase; ▲ free lipase

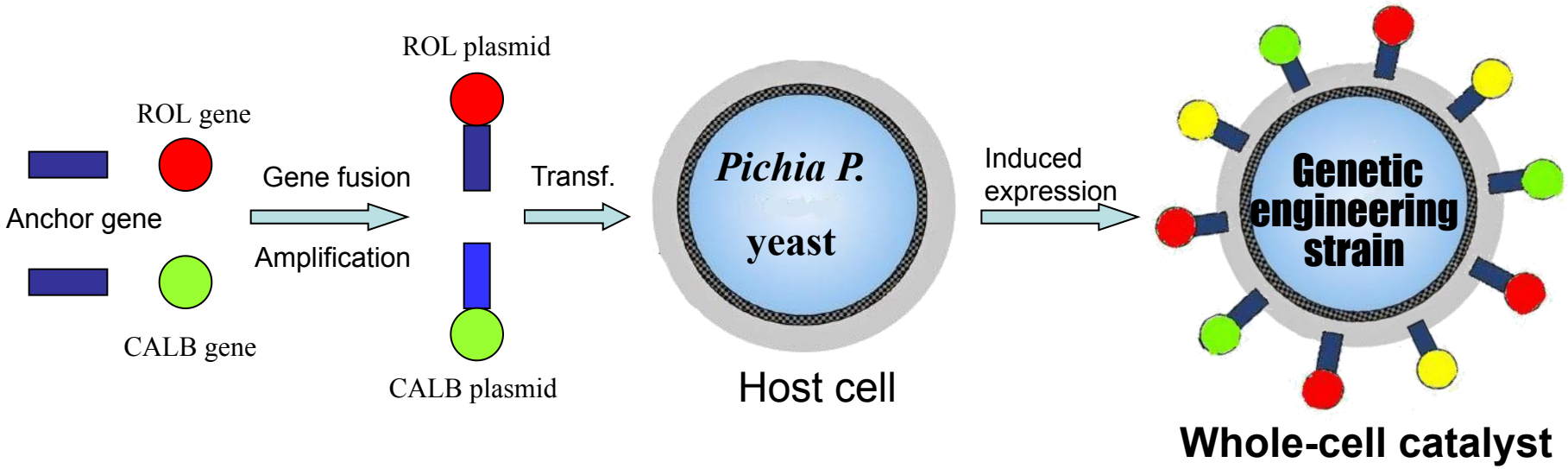
Immobilization of Lipase Using Paper Making Technology

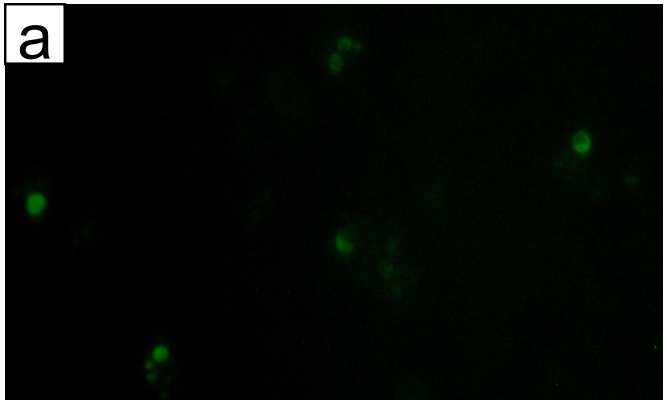


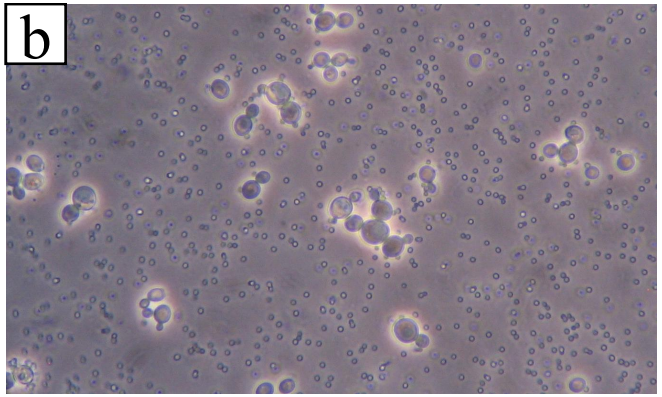


The immobilized lipase was used to catalyze transesterification of oil to make biodiesel, and it could be repeatedly used for 10 times.

▲ Whole-cell Biocatalyst with Surface Displaying







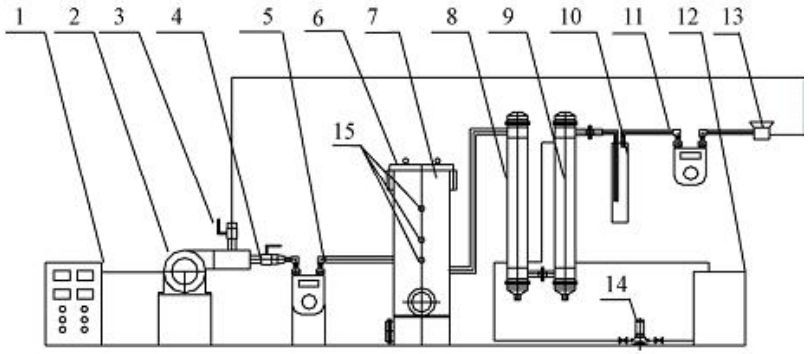
▲Biodiesel Industry

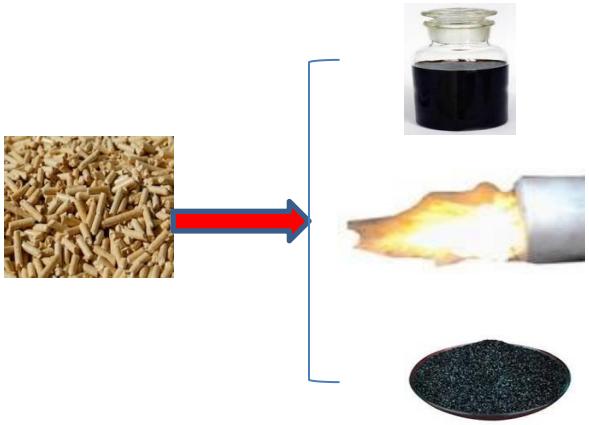
There are more than 100 biodiesel production companies in China, the total production of biodiesel is 1.2 million tons per year.

Jiangsu Kate New Energy Co. Ltd，Biodiesel Capacity of 200000 t/a

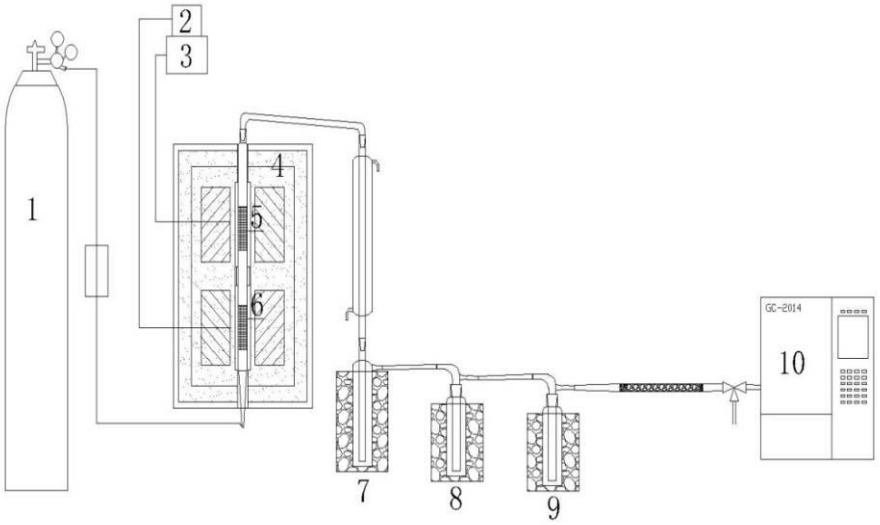
3. Biomass Gasification and Electricity

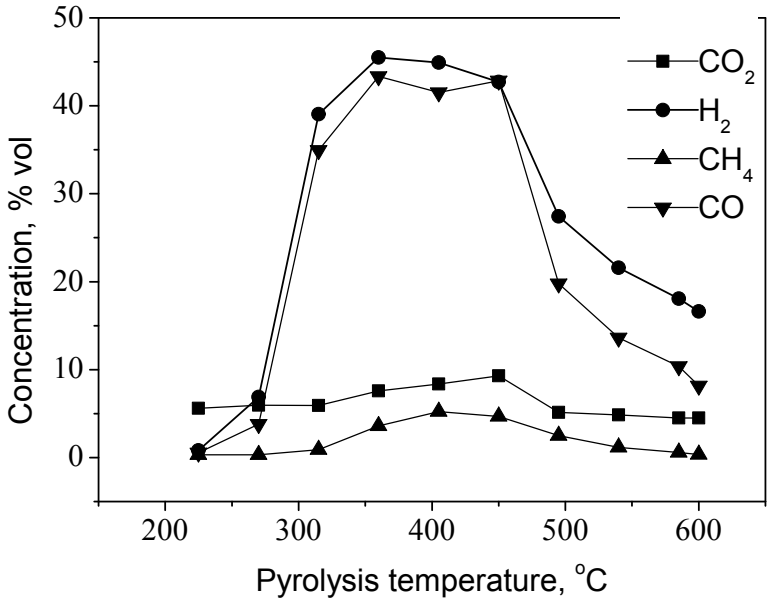
Poly Generation of Gas, Solid and Liquid Products by Biomass Gasification





Preparation of High Purity Synthetic Gas by Catalytic Pyrolysis





Biomass Gasification and Power Generation Industry

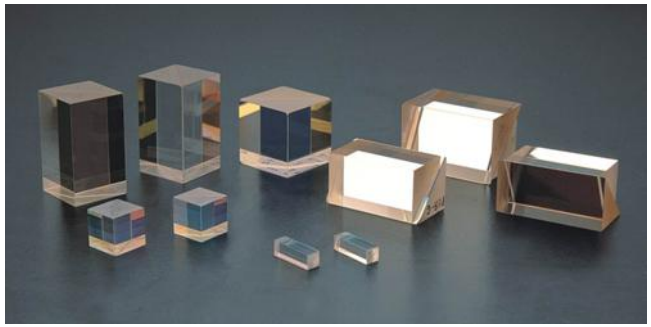
There are more than 250 companies for biomass gasification and power generation in China, and the total installed capacity through biomass gasification is 6000 megawatt.

In China, KADI Bioenergy Co. Ltd is the biggest company in biomass gasification and power generation, and its installed capacity is 1180 megawatt.

4. Agro-forest Biomass-based Materials

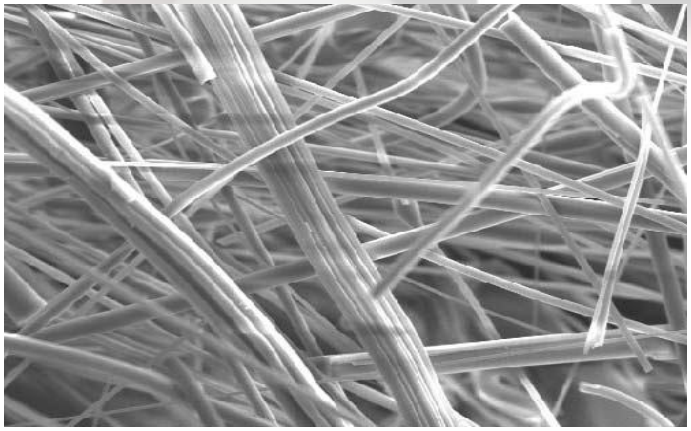
PLA and Biomedical Materials

Biodegradable Plastics and Related Products



Wood/Plastic Composite

Cellulose Nano Fibers



Challenges to Forest Biomass-based Energy and Materials in China

▼ **Higher cost compared to fuels and materials from petroleum**

At the present, the price of fossil resource petroleum has dropped down while the price of raw materials for biomass-based energy and materials has been slightly increasing.

▼ **Maturity of the technologies needs to improve**

Fossil fuels and materials have long history and higher maturity of technology, but forest biomass-based energy and materials has been going through a short period. We still have long way to go.

▼ **Need to make sure if the forest resource security is sustainable**

It is possible that we may lack of enough forest resources once the forest biomass–based energy and materials were widely used.

Prospect of Forest Biomass-based Energy and Materials in China

▼ It is necessary for our China to develop forest biomass-based energy and materials because we don't have enough fossil resources.

▼ Chinese national strategy demand will promote the development of agro-forest biomass-based energy and materials.

▼ Government and companies have been investing more to support the development of biomass energy and materials, and a big number of Chinese researchers and scientists have been making great contribution to this field.

▼ China has big area to culture energy plants and has plenty of forest resources for biomass-based energy and materials use.

The forests in China are primarily distributed in Fujian, Jiangxi, Guangxi, Zhejiang, Guangdong, Hainan, Hunan and Yunnan provinces, and their forest coverage is over 50%.

China has a average of 21.63% forest coverage, its forest area is about 510 million acre, and among the forests there are 171 million acre of planted forests which can be harvested for industrial use.

The forest reserves in China are around 15.1 billion cubic meters, and the annual average forest harvest is 334 million cubic meters.

The amount of forest logging residues and wood processing residues in China is 109, 42 million tons per year, respectively. The amount of forest residues each year is equivalent to 105 million tons of standard coal.

Also there are plenty of inedible woody plant oils to make biodiesel

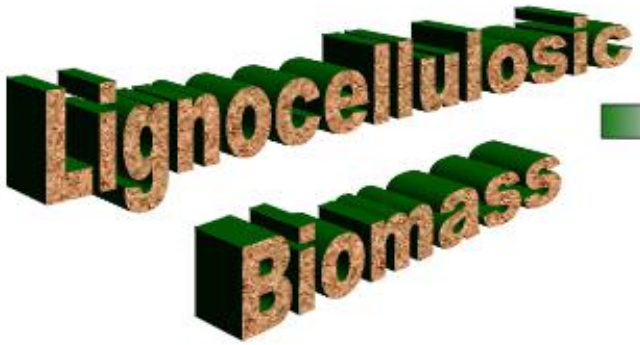
Pistacia chinensis (黄连木) seed

Jatropha curcas (麻疯树) seed

Sapium sebiferum (乌桕树) seed

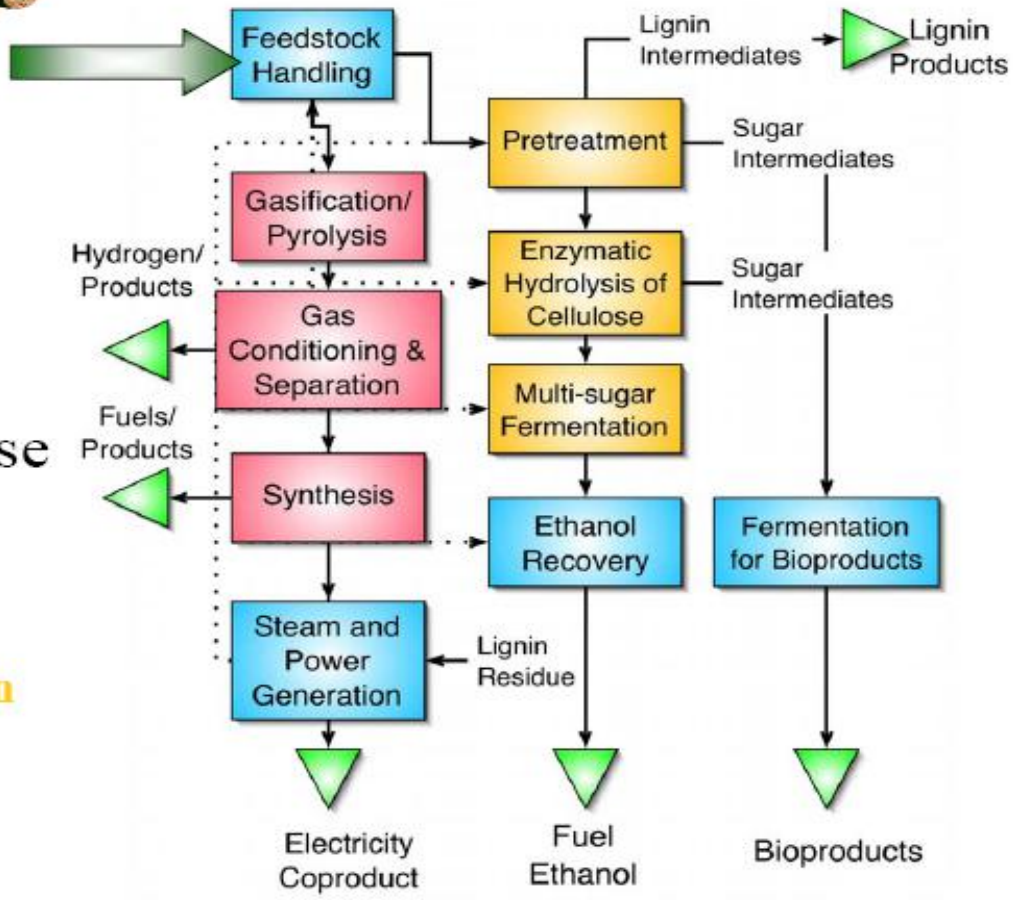
Swida wilsoniana (光皮树) seed

▼ Finally, we can make it available to comprehensively utilize forest biomass resources by biorefinery.



An integrated biorefinery makes use of:

- Thermochemical conversion technology
- Biochemical conversion technology
- Existing technology



Thanks for Your Attention

Welcome You to Make Collaboration with Us