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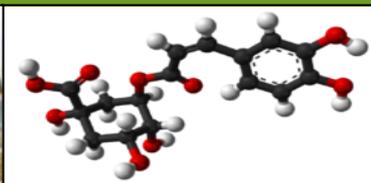
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# Substitution of chemical phenols by plant polyphenols for processing phenolic biomaterials



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## WORLD ANNUAL PRODUCTION OF PHENOL

2000 : 6 million tons  
 2010 : 8 million tons  
 2020 : 12 million tons (prediction)

Market in expansion

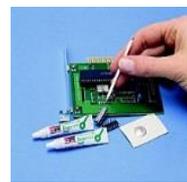
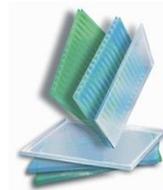
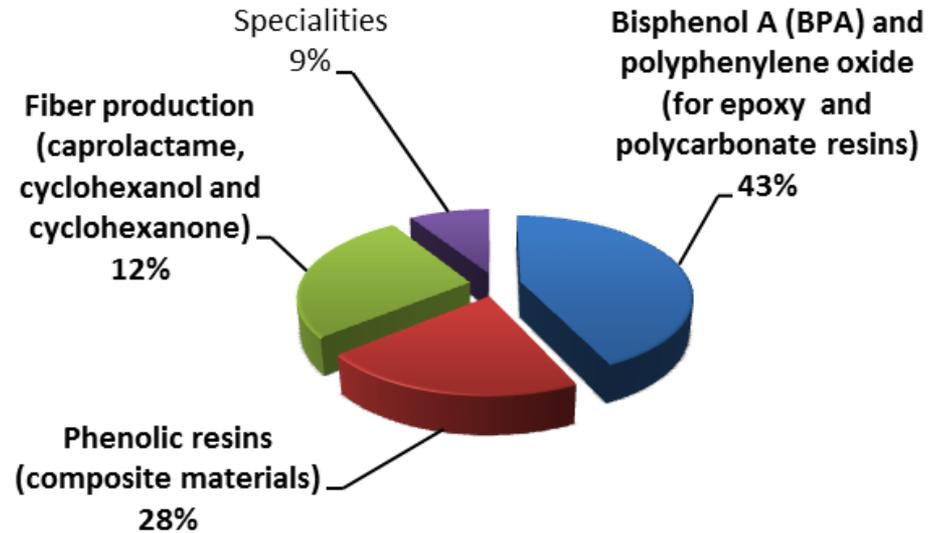
New production plant in Nanjing, China (INEOS and SINOPEC) : 400 000 tons (end 2013)

## EUROPEAN PHENOL USE

2 million tons per year ; more than 80% for plastic materials and resin

## APPLICATIONS

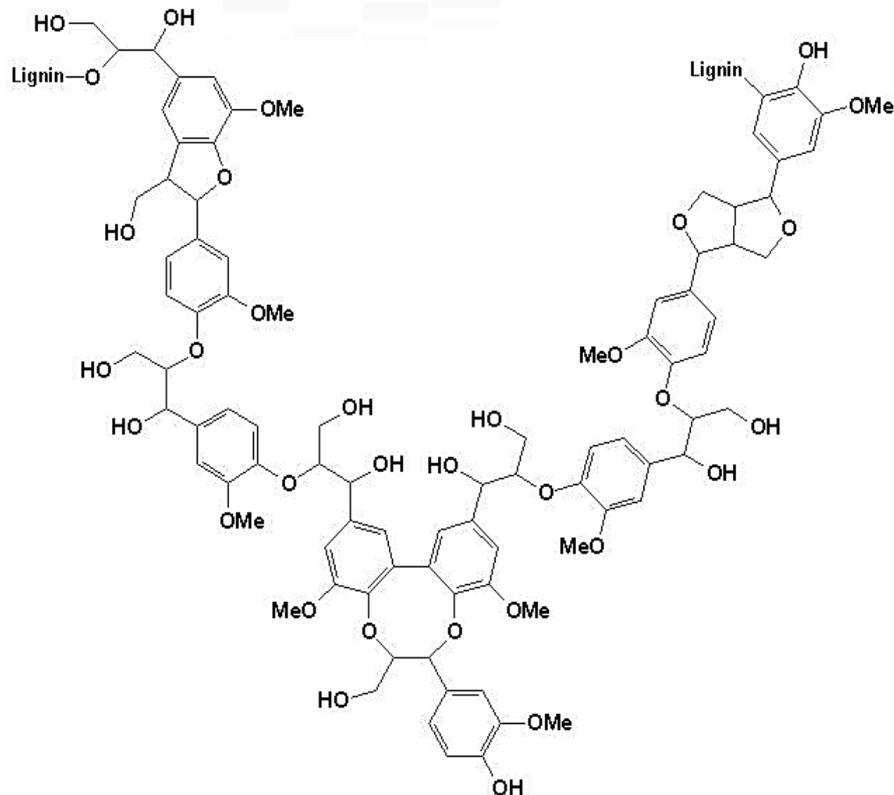
- Plastic materials : thermosetting (polycarbonate, epoxy)
- Plastic fibers : nylon (polyamide)
- Electric isolating
- Bactericid paint
- Hydrophobic coating
- Anionic detergent
- Thermic ink
- Insulating glue





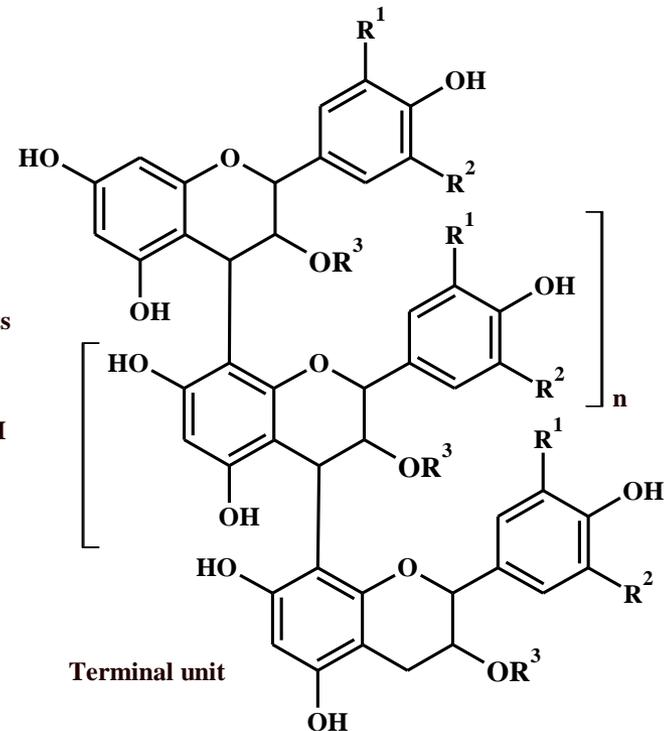
**Need to find quickly alternatives to petroleum-based aromatic compounds to halt the massive contamination of our environment and protect human beings from its negative impacts on health**

## Substitution of chemical phenol by natural polyphenols



Lignin

Extension units

 $R^1, R^2 = \text{OH or H}$   
 $R^3 = \text{H, Gal}$ 


Terminal unit

**Condensed  
tannins**

# RESEARCH WORKS



# RESSOURCES

Agro-industrial wastes  
(wine and cider making, fruit juice)



Pomace, fruit marcs

Winemaking Biomass	seeds	pomaces	stems
Annual output	80 000-140 000 t	700 000 t	300 000 t
Tannins (% DM weight)	6 -16%	0,04 - 1,2%	3%

Sawmill co-products and forest biomass



Barks



Pine needles, leaves

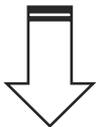
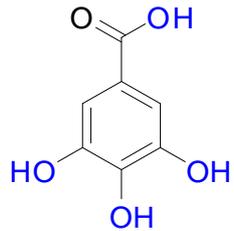


Conifers (36%)  
France

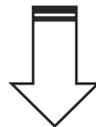
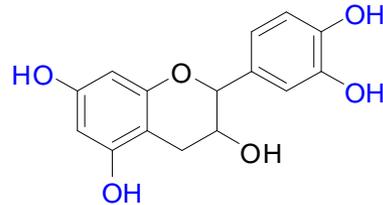
French Forest  
16 000 000 Ha  
2,5 billions m<sup>3</sup>

- From phenolic models

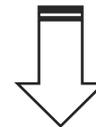
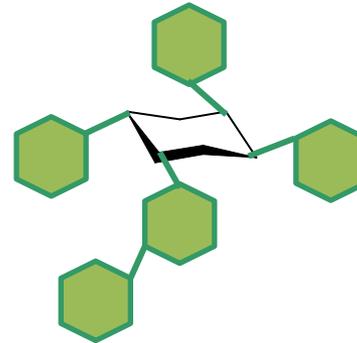
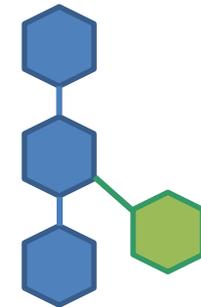
Gallic acid



Catechin



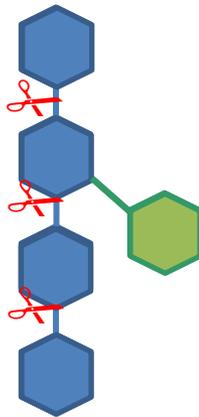
- From commercial extracts

Hydrolysable  
tanninsCondensed  
tannins



## DEPOLYMERIZATION : a key step

- ⇒ to get an homogeneous raw material or fine chemicals
- ⇒ to get the same synthons from different tannin sources
- ⇒ to suppress one step (simultaneous extraction/depolymerization)

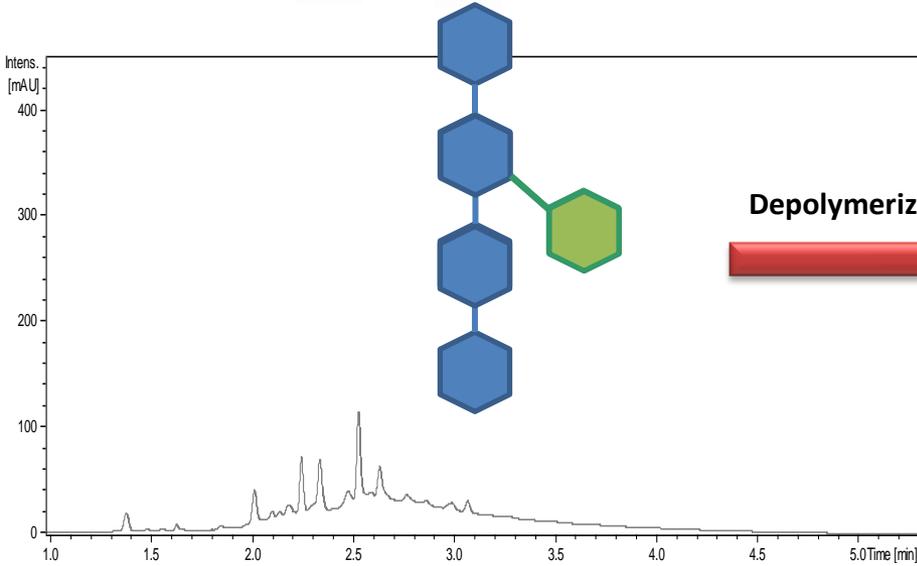


Depolymerization

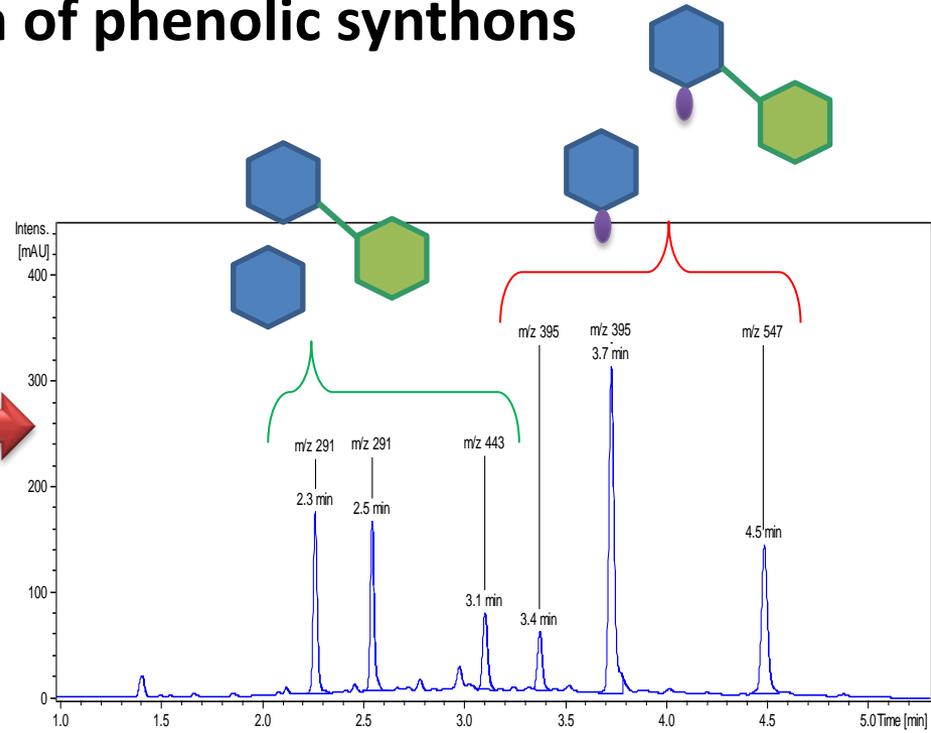


Large scale process for production  
of biobased phenols

⇒ **DEPOLYMERIZATION : obtention of phenolic synthons**



Depolymerization





Fonctionnalization



Curing

Epoxy resins  
(thermosetting)

## Perspectives

- **Materials :**  
thermoplastic ; polyester, polyamide, vinylester,... and composite
- **Fine chemistry :**  
Medicinal, cosmetic  
Lubricant  
Surfactant

Thank you for your attention !



## Co-workers

*Lucas Suc*

*Guillaume Billerach*