

Wood Adhesives made with Pyrolysis Oils

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Wood-based panels

Wood particles/fibres/strands or veneers are blended/coated with a mix of resin and additives and formed to a composite mat.

The composite mat is hotpressed to form a panel product.





Applications

The panels are used in furniture manufacture and as materials for construction and decorative improvement.

Due to their cost effectiveness they replaced solid wood since early 1900s.











Wood-based panels production & consumption*

Global production in 2017:

- \circ Wood-based panels = 402 million m³
- Plywood = 157 million m^3
- \circ Particleboard, OSB and fibreboard = 245 million m³

Major producers - Percentage of global production (2017):

China (50%); United States of America (9%); Russian
Federation (4%); Germany (3%); Canada (3%); Poland (3%);
Brazil (3%).

Major consumers - Percentage of global consumption (2017):

China (48%); United States of America (12%); Germany (3%);
Russian Federation (3%); Poland (3%).

*Source: FAOSTAT database, http://www.fao.org/forestry/statistics/80938/en/ http://www.fao.org/forestry/statistics/80938@180723/en/



Phenol-Formaldehyde resins

- An important type of wood adhesives in terms of performance, efficiency, and applicability in the production of exterior grade wood panels
- Thermosetting polymers derived by the condensation polymerization of formaldehyde (F) with phenol (P)



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Resole structure

Why using pyrolysis oils in PF adhesives

- Phenol is a petrochemical product and its price is directly affected by the increase in oil prices.
- Increased environmental awareness has put a pressure on reducing the use fossil fuels and has promoted the use of alternative raw materials derived from renewable resources.
- Pyrolysis oils (bio-oils) are derived from the pyrolysis of lignocellulosic biomass and a significant portion of them comprises of phenolic compounds (catechol among others), which stem from the depolymerisation of lignin and could replace part of the phenol needed in the formulation of a phenol-formaldehyde resin.
- > Diverse and renewable biomass feedstocks can be used
- Bio-oil PFs will promote sustainable development of the resin and wood-based panel industries.
- Industry target: same or even enhanced adhesive performance at the same or lower cost as compared to conventional resins.



CHIMAR bio-oil PF resins



Synthesized by partial substitution of feedstock phenol with bio-oil. The resin monomers or oligomers are replaced by bio-based compounds.

Substitution levels of phenol, 10 - 50%.

Bio-oils derived from various wood/plant feedstocks.

Whole or fractionated bio-oil samples were used.

Adhesives for plywood, OSB and particleboard were developed and tested.

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► Tests and achievements at the laboratory, pilot and industrial scale.

Challenges include not defined and not constant composition, high viscosity, MW and reactivity, dark color and acute smell.

The limited availability at commercial scale hinder widespread industrial adoption....

Comparison of differential MW fractions in resins





Comparison of second derivatives of the FT-NIR spectra of resins



Conventional (standard) & bio-oil (modified) PF resins for plywood





Mechanical strength (IB, MOR), water resistance (TS) and bonding durability (BD) of pilot scale OSB





Bond quality of industrial plywood



Remarks and Considerations

- Pyrolysis oils provide PF resins with equal reactivity and performance to conventional resins
- > 50% phenol substitution was realized and further more is envisaged
- Pyrolysis oils are less toxic than phenol and conform to the requirements of sustainable development

- Biomass diversity and complexity
- > Biomass availability & lack of developed supply chain
- > Immature conversion technologies
- Feedstock storage & product shipment
- Performance of bio-oils
- Lack of standards
- Companies to produce bio-oils
- > Costs

To take home

- CHIMAR continuously evaluates the option of "green" wood adhesives focusing either on the replacement of petrochemical raw materials by others of natural origin or on the development of totally natural binder systems.
- The aim is to provide feasible and cost effective resin solutions based on regionally available biomaterials.
- This research paves the way for the development and commercial adoption of natural resins for wood products, offering significant competitive advantage to the resin and panel industries and helping to increase the positive environmental impact.



CHIMAR in brief

CHIMAR HELLAS SA is an R&D SME, located in Thessaloniki, Greece, that provides services to the resin and wood-based panel industries all around the world.

CORE Business

- 1 Development & Application of Industrial Technology for Binders & Additives
- 2 Engineering Services & Equipment Supply for resin plants
- 3 Technical Support & Training Services for resin & panel manufacturers
- 4 R&D Services for 3rd parties
- 5 Participation in EU research projects

Specialty SERVICES

- 1 Chemicals production upon request
- 2 Accredited testing (EN 17025)
- 3 Resin, Additives & Board testing and evaluation
- 4 Equipment Representation

- ✓ Acting globally
- ✓ Helping locally
- ✓ Focus on safe, environmentally friendly products and technologies:
- Technology for bio-based adhesive systems

CHIMAR in figures

- Since 1977 with presence in <u>40+ countries</u>
- Know-how applied in <u>100+ industrial sites</u>
- Over <u>1.4 Million Tons/year of resin</u> produced by customers under CHIMAR technology
- Over <u>10% of global wood panel production</u> uses CHIMAR services (PB & MDF)
- Engineering/Procurement of more than 15 turn-key formaldehyde & resin plants worldwide
- Over 20 patent families in >50 countries
- Participation in <u>60+ EU funded projects & scientific</u> <u>networks</u>
- Strong team of 32 highly motivated experts
- Customers follow CHIMAR since the company's day 1





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ENBA European Network for Biological Adhesives

