NATURAL FLAME RETARDANTS FOR PLASTICS

NATURAL CLAY MINERALS MODIFIED WITH PHOSPHORIC DERIVATIVES LIGNIN AND CHITOSAN

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Introduction

Increasing fire safety requirements and the need to reduce the environmental impact of synthetic flame retardants drive the search for natural, effective, and sustainable solutions.

This proposal introduces flame retardants based on clay minerals modified with phosphoric acid derivatives, lignin, and chitosan to improve the mechanical and flame performance of polymer systems.

Why Natural Clay Minerals?

- **Renewable Sources**
- **Effective Fire Protection**
- **Low Environmental Impact**
- **Alignment with Sustainability**

Low Environmental Impact

- **Potential for Modification & Functionalization**

Natural clay minerals offer renewable sources, low toxicity, and effective flame-retardant properties, making them ideal for sustainable polymer development.

Natural Clay Minerals
(Base Flame Retardants)

- Kaolin
- Bentonite
- Talc
- Montmorillonite
- Clinoptilolite

Kaolin Bentonite Talc Montmorillonite Clinoptilolite

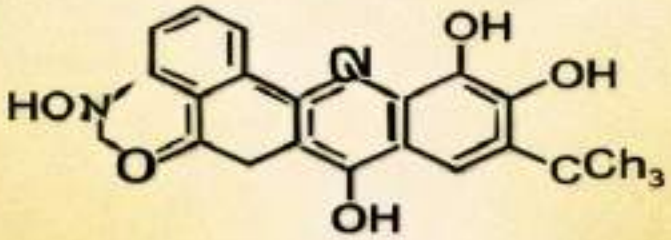
These minerals act as natural flame-retardant bases due to their layered structure, thermal stability, and ability to form protective barriers during combustion.

Modification with Bio-Based Additives

Phosphoric Acid Derivatives

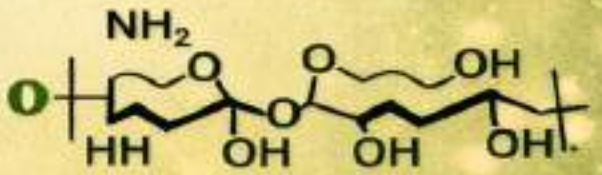
Char Formation & Flame Inhibition

Lignin



Enhanced Carbon Yield & Thermal Stability

Chitosan



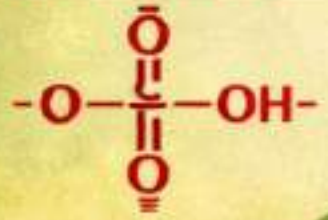
Nitrogen Enrichment & Adhesion Improvement

Clay Mineral

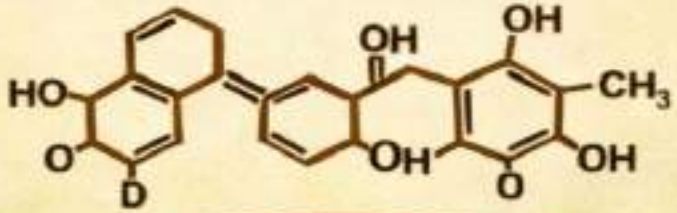
Bio-based additives enhance natural flame retardants for plastics, creating effective and eco-friendly hybrid systems.

Synergistic Modification Mechanism

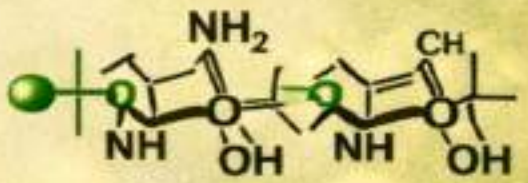
Phosphoric Acid Derivaiives



Lignin



Chitosan



Carbon Shield

Char Formation

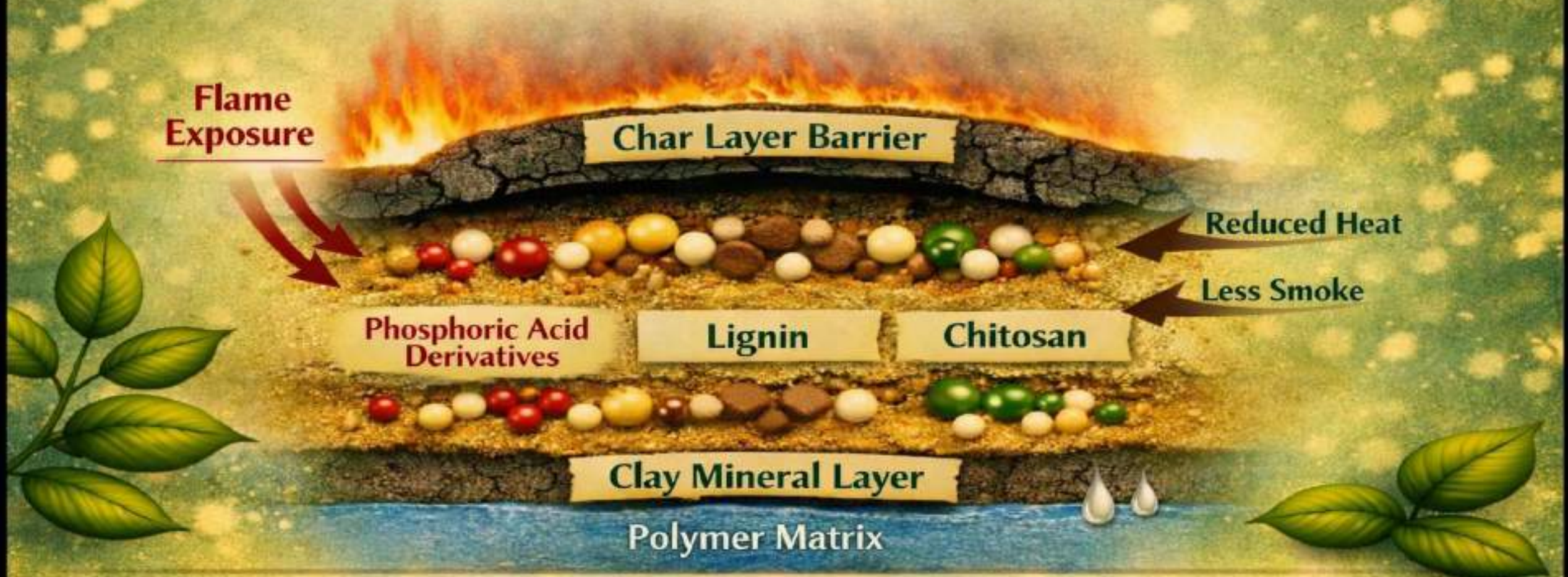
Enhanced Bonding

Clay Mineral

Enhanced Flame Retardancy & Stability

Phosphorous derivatives, lignin, and chitosan are adsorbed onto or or anchored to the mineral surface, forming a stable composite structure. This combination enhances flame retardancy, mechanical performance, and environmental compatibility.

In Action – Heat & Flame Protection



Upon heat exposure, the hybrid system forms a protective char layer reinforced by mineral and bio-based components.

This barrier slows heat transfer, reduces smoke emission, and prevents polymer dripping.

Environmental & Safety Benefits

Reduced Toxic Emissions

Less Smoke
& Harmful Gases

Improved Material Stability

Increased
Heat Resistance

Eco-Friendly Composition

Halogen-Free
& Non-Toxic

Enhanced Safety in Use

Lower Fire Risk
& Better Protection

Bio-based flame retardant systems minimize environmental impact while improving fire safety and mechanical performance.

Their halogen-free composition ensures cleaner combustion and sustaine material design.

Performance Summary

Thermal Resistance

Mechanical Strength

Smoke Emission

Flame Spread

Eco Impact

The synergistic system combining phosphoric acid derivatives, lignin, and chitosan with clay minerals ensures balanced performance — improved flame retardancy, mechanical integrity, and environmental compatibility.

Applications in Polyolefins

Polyethylene (PE)

Polypropylene (PP)

Pipes

Packaging

Automotive Panels

Textiles

Natural clay minerals modified with phosphoric acid derivatives, lignin, and chitosan enhance the flame retardancy and durability of pi yolyolefins while maintaining environmental safety.

Potential Applications

Automotive Industry

Building & Construction

Electrical & Electronics

Textiles & Fibers

Packaging

Final Conclusions

Synergistic Effect

Effective Fire Barrier

Material Integrity

Stable & Durable

Environmental Advantage

Eco-Friendly Solution

Future Perspertive

Innovative Potential

Sustainable and high-performance flame retardant systems for safe, durable, and environmentally responsible materials.