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Bio-based flame retardant derived from L-alanine for improved fire safety of cotton textiles

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Advantages of Cotton:

- High water absorption
- Good air permeability
- Softness and comfort
- Biodegradable and environmentally friendly
- Many application from clothing to car upholstery



Disadvantages of Cotton:

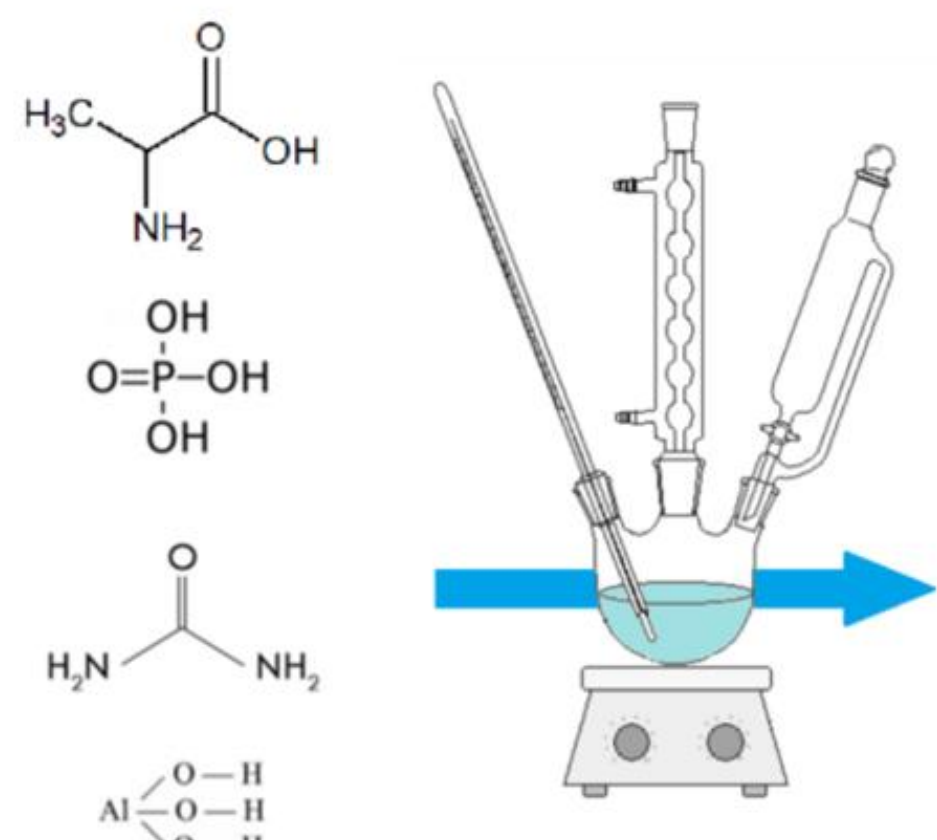
- Low Limiting Oxygen Index (LOI) of about 18%, making it flammable



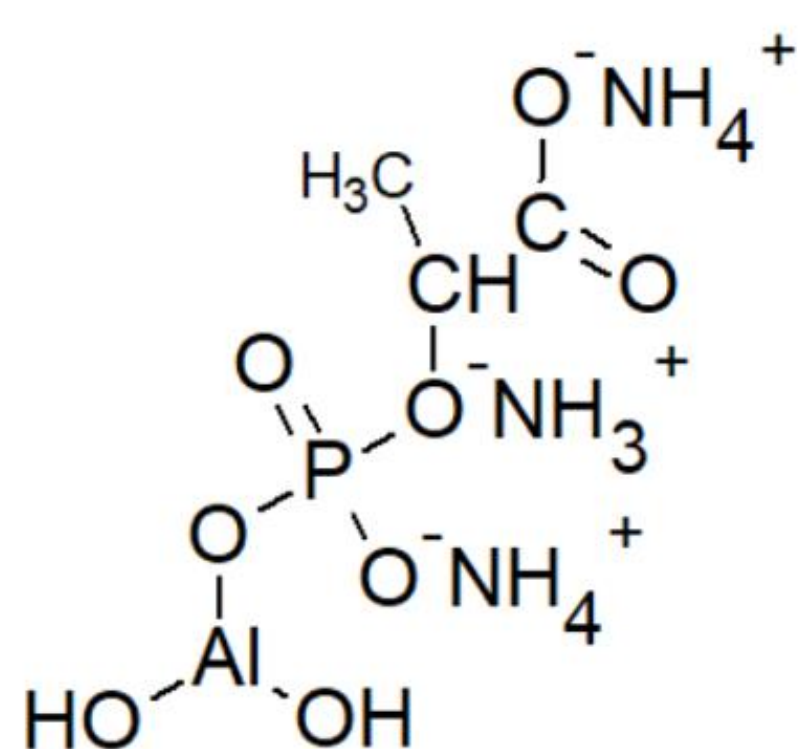
Flame retardants are chemicals that are applied to materials to prevent the start or slow the growth of fire. Some of these chemicals are associated with adverse health effects in animals and humans.

The aim of the project is to reduce the flammability of cotton fabric.

Synthesis

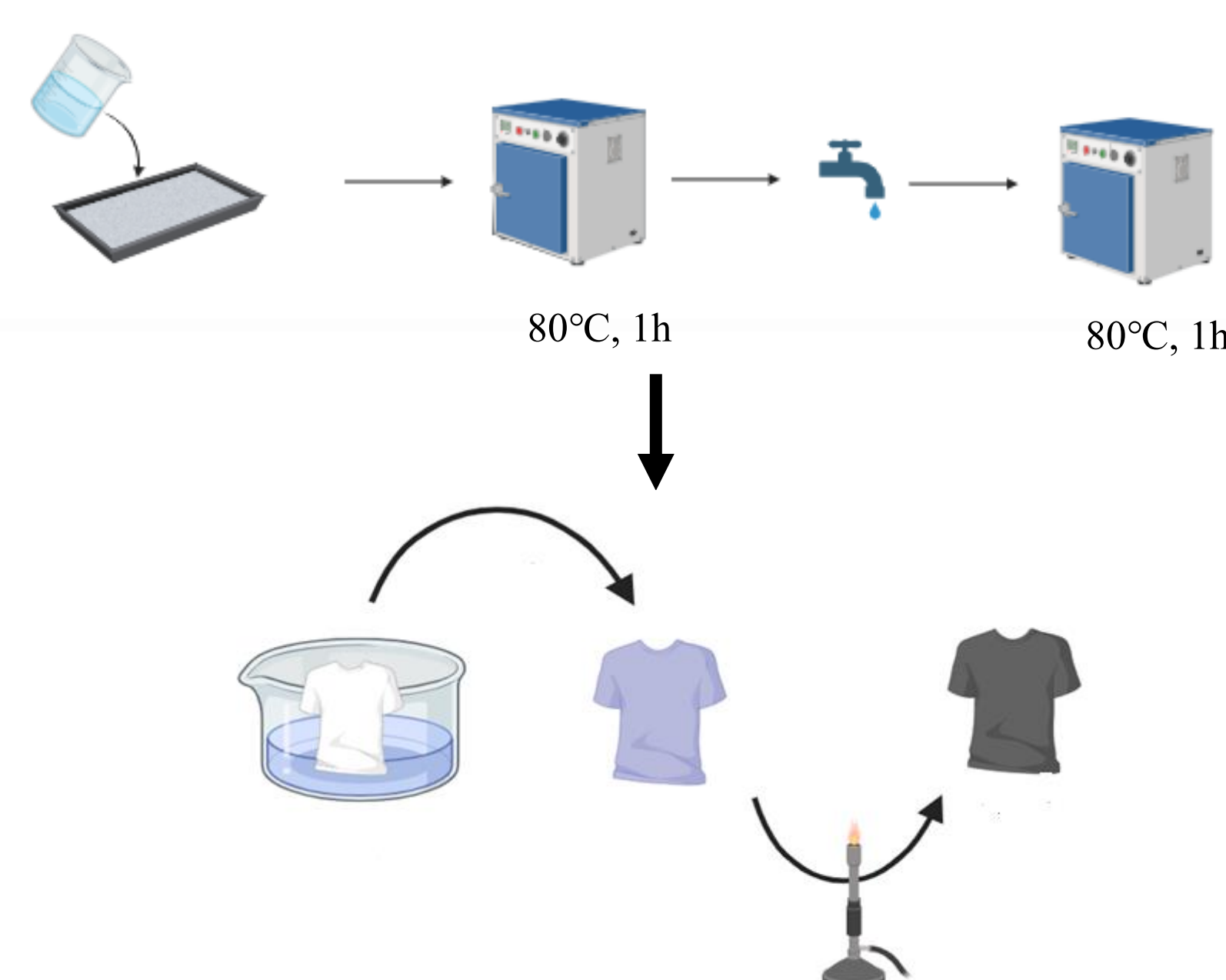


No need to use a catalyst



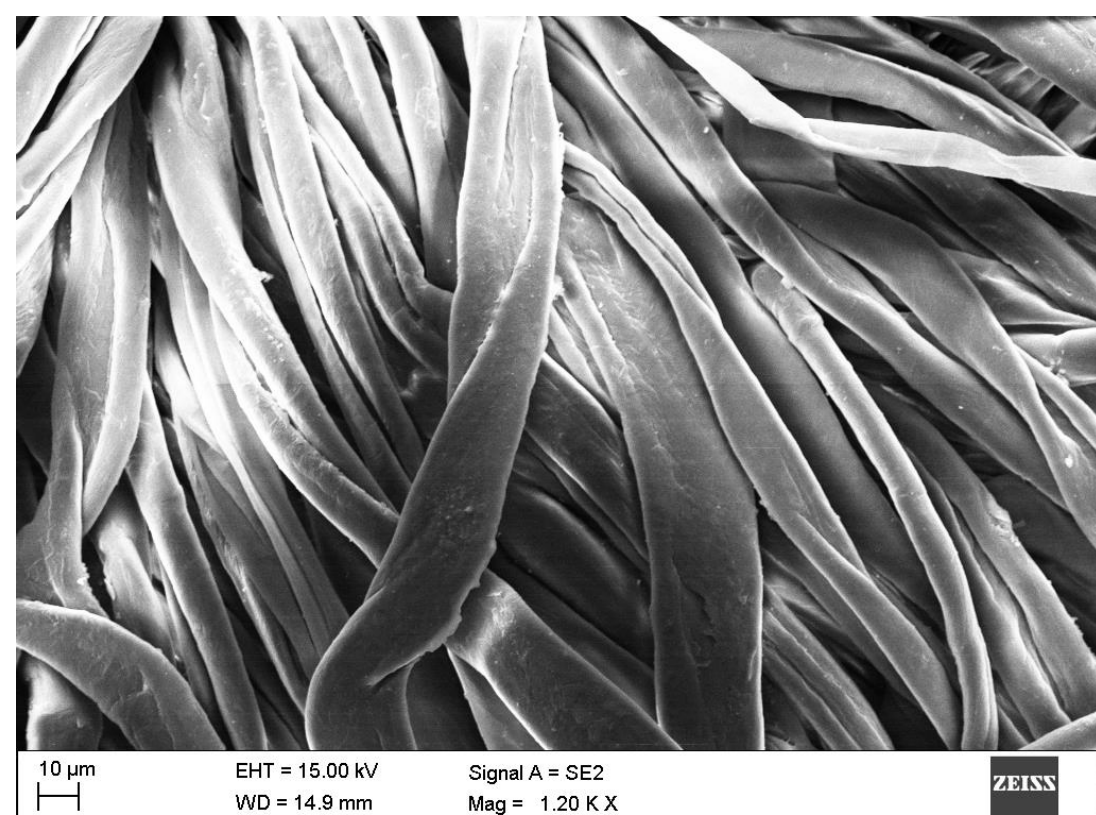
Flame retardant ALA-FR

Application

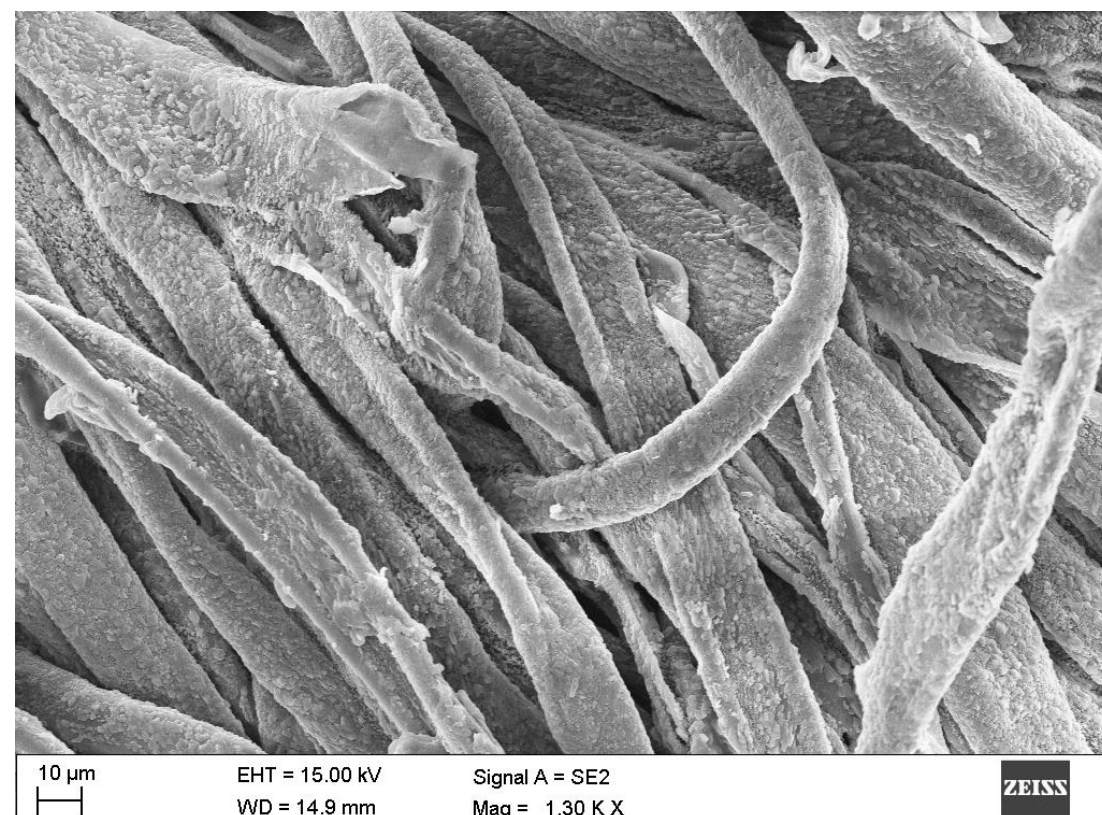


Characterisation

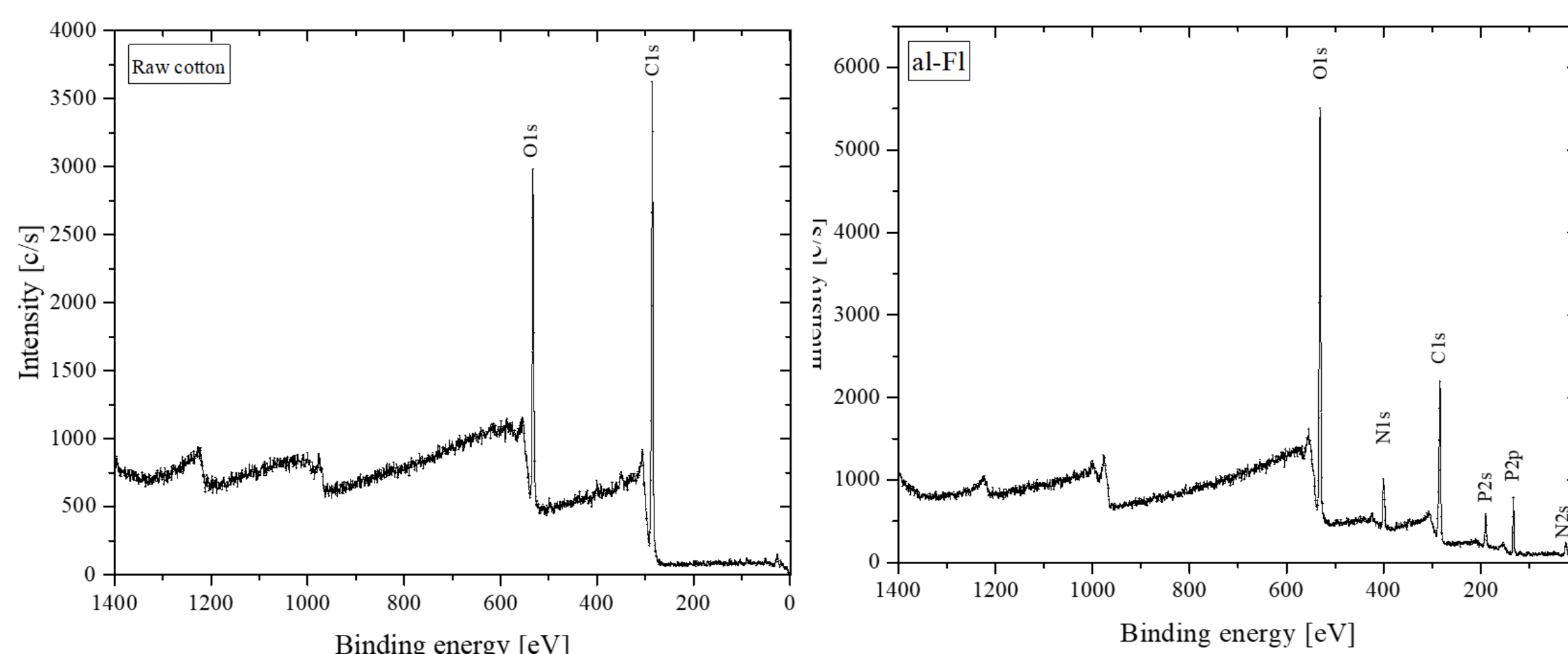
Raw cotton



Cotton soaked in 30% ALA-FR

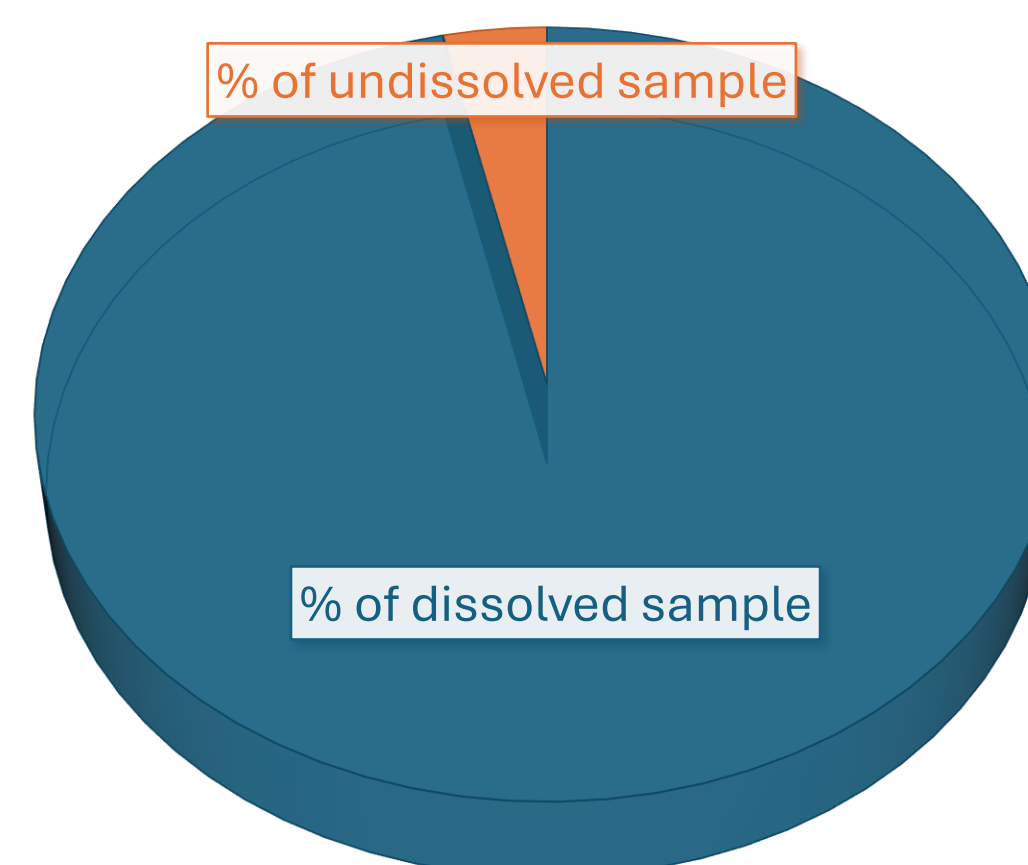


The SEM images show smooth, ribbon-shaped raw cotton fibers on the left, while on the right, fibers are covered with a rough, irregular layer after flame retardant application, indicating a surface modification.

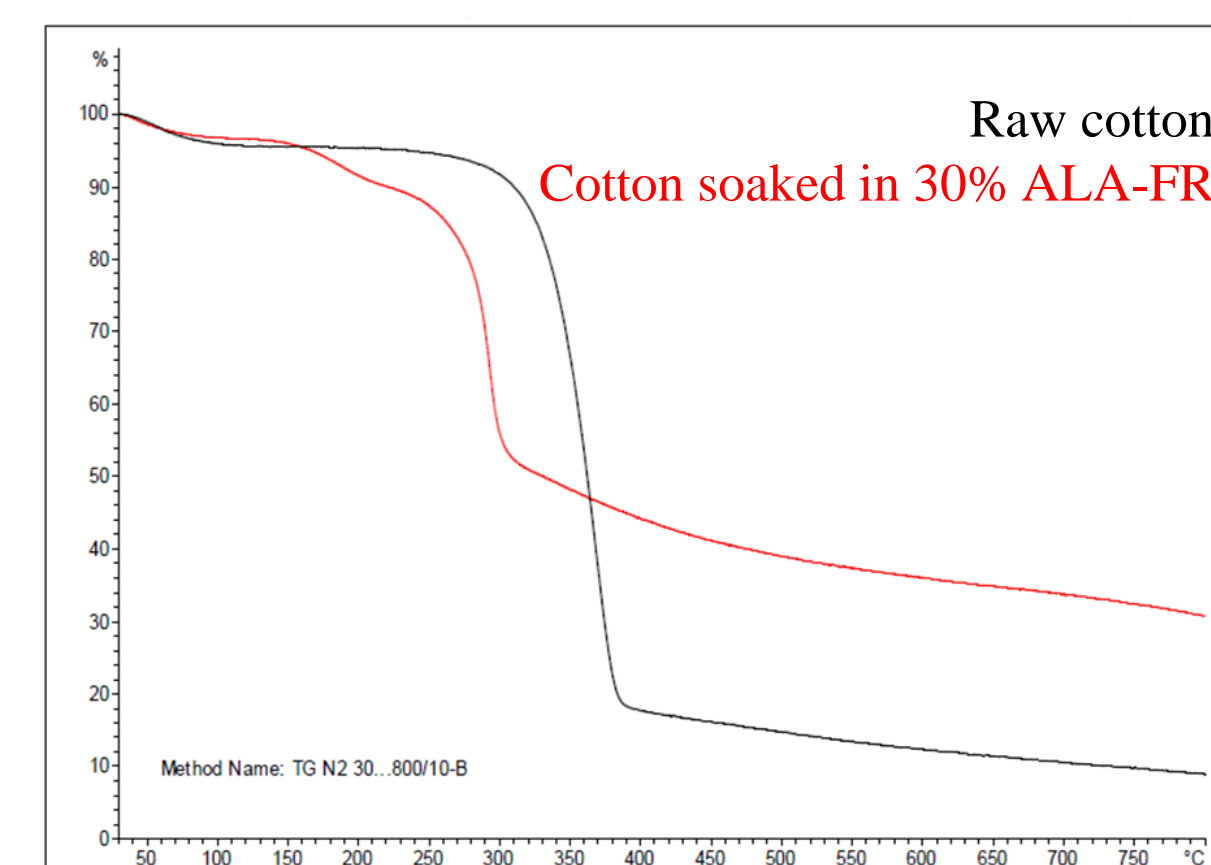
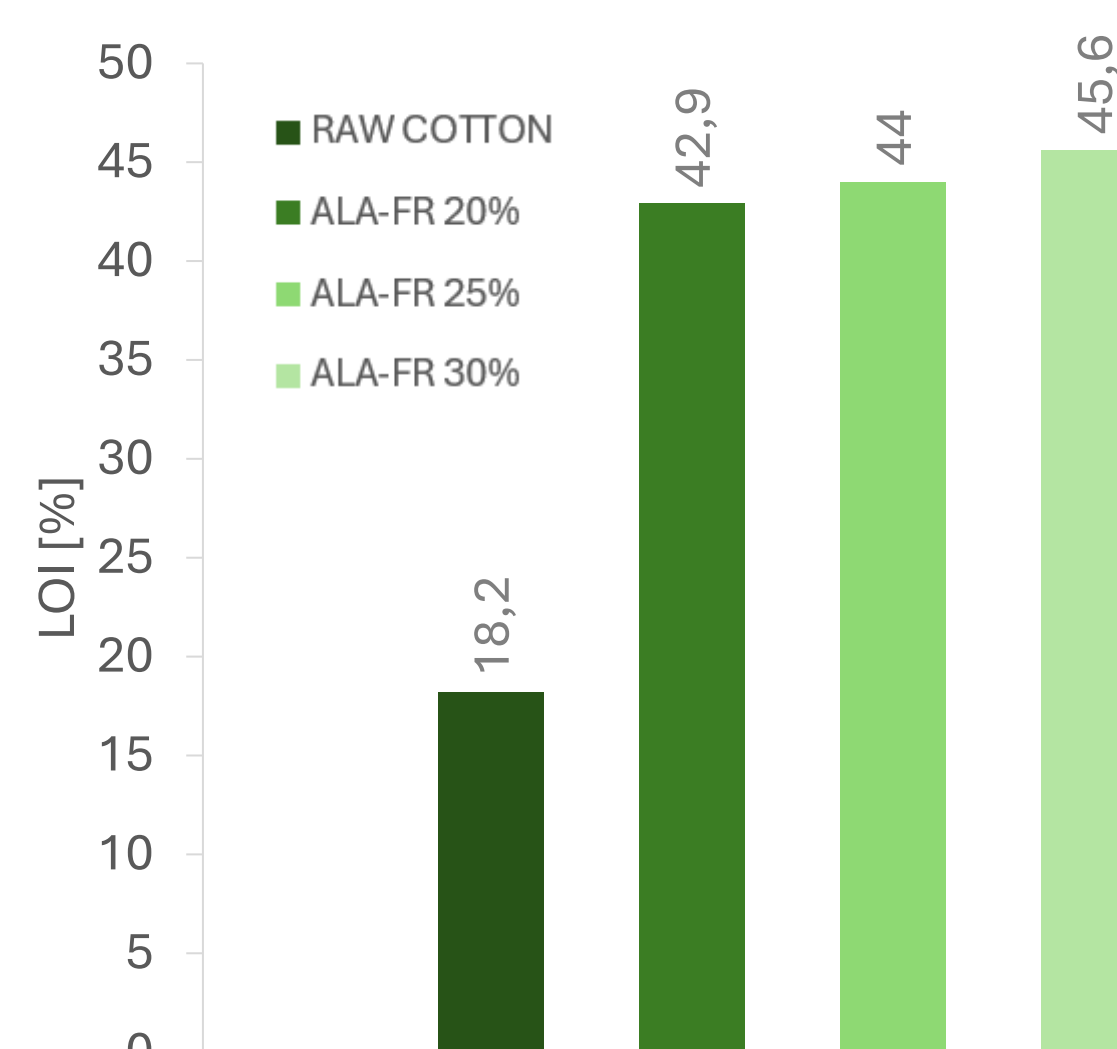


The XPS spectrum of pure cotton (left) displays typical C 1s and O 1s peaks, while cotton treated with 30% ALA-FR (right) shows additional N 1s and P 2p peaks, confirming uniform deposition of nitrogen and phosphorus from the flame retardant.

Effectiveness



The water solubility of a sample of fabric flame retardants is an extremely important parameter, as it is essential for applying the flame retardant to the fabric



Pure cotton fabric (black line) shows weight loss between 300°C and 400°C due to pyrolysis, while the flame-retardant-treated fabric (red line) demonstrates improved thermal stability with slower weight loss and delayed degradation.

LOI is defined as the minimum concentration of oxygen in the nitrogen/oxygen mixture that is required to sustain combustion of the test sample under the test conditions

The higher the LOI value, the lower the susceptibility to fire.

Conclusion



The resulting flame retardants reduce the risk of fire, making them a promising solution in the context of fire protection, but further research is needed.

The result of the work carried out is the submission of a patent application to the PR Patent Office entitled. 'Method of manufacturing an agent based on an amino acid and phosphoric acid for reducing the flammability of natural fibre fabrics' The application received the number P.449284.

Future plans

