

**Composite films of hydroxyethyl cellulose (HEC),  
carboxymethylcellulose (CMC) and O-acetyl-  
galactoglucomannans (GGM) cross-linked by citric acid  
(CA)**

Victor Kisonen<sup>1</sup>, Petri Ihalainen<sup>2</sup>, Parvez Alam<sup>3</sup>

1) Åbo Akademi University, Process Chemistry Centre, Laboratory of Wood and Paper Chemistry, Turku / Electronic Innovation and Consulting Lohja Oy, Finland

2) Åbo Akademi University, Laboratory of Physical Chemistry, Turku, Finland

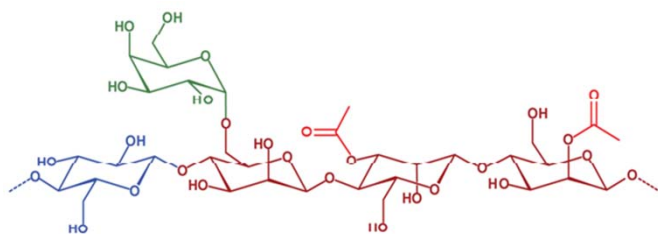
3) Åbo Akademi University, Laboratory of Paper Coating and Converting, Turku, Finland

- The aim was to reinforce CMC-GGM and HEC-GGM films with citric acid for food packaging purposes
  - ✓ Enhanced mechanical properties and hydrophobicity
  - ✓ Just water in processing

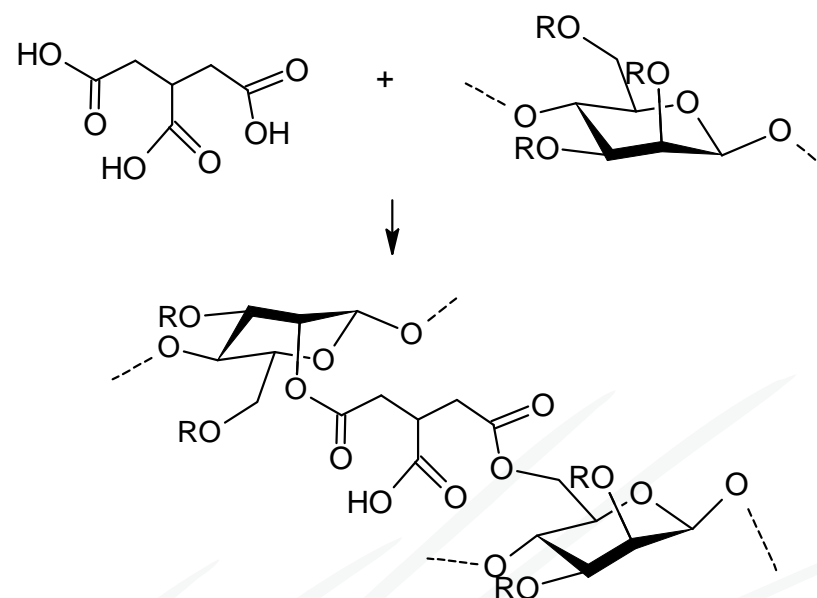




- ✓ CMC or HEC with 20 wt-% of GGM
- ✓ Up to 8 wt-% of citric acid
- ✓ Curing at 150 °C for 3-12 min

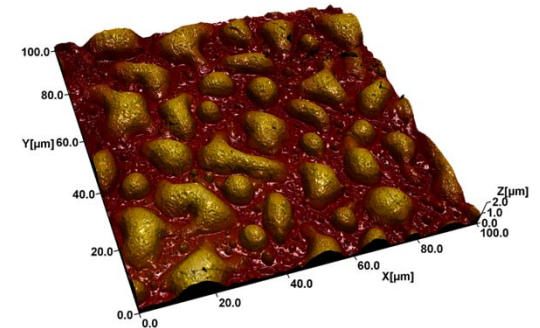
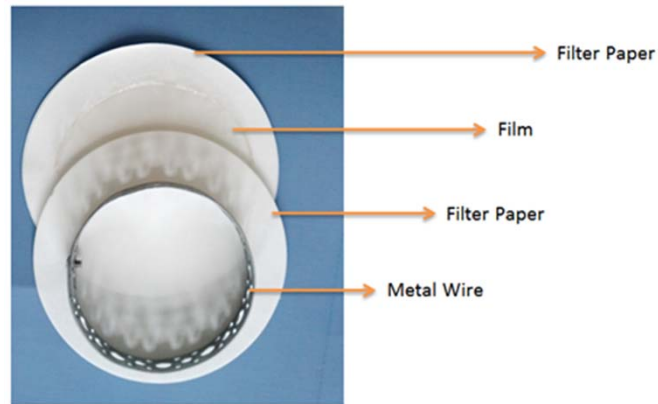
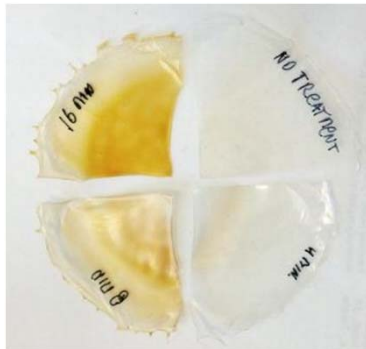


O-acetyl-galactoglucomannans (GGM)



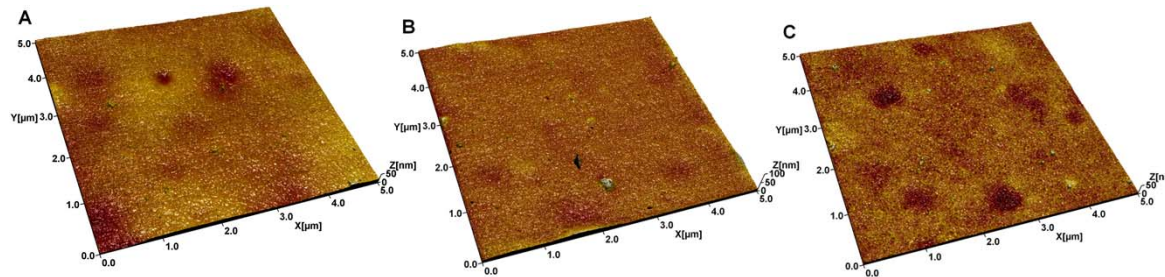
R = H, OCH<sub>3</sub>, CH<sub>2</sub>CH<sub>2</sub>OH or CH<sub>2</sub>CO<sub>2</sub>H



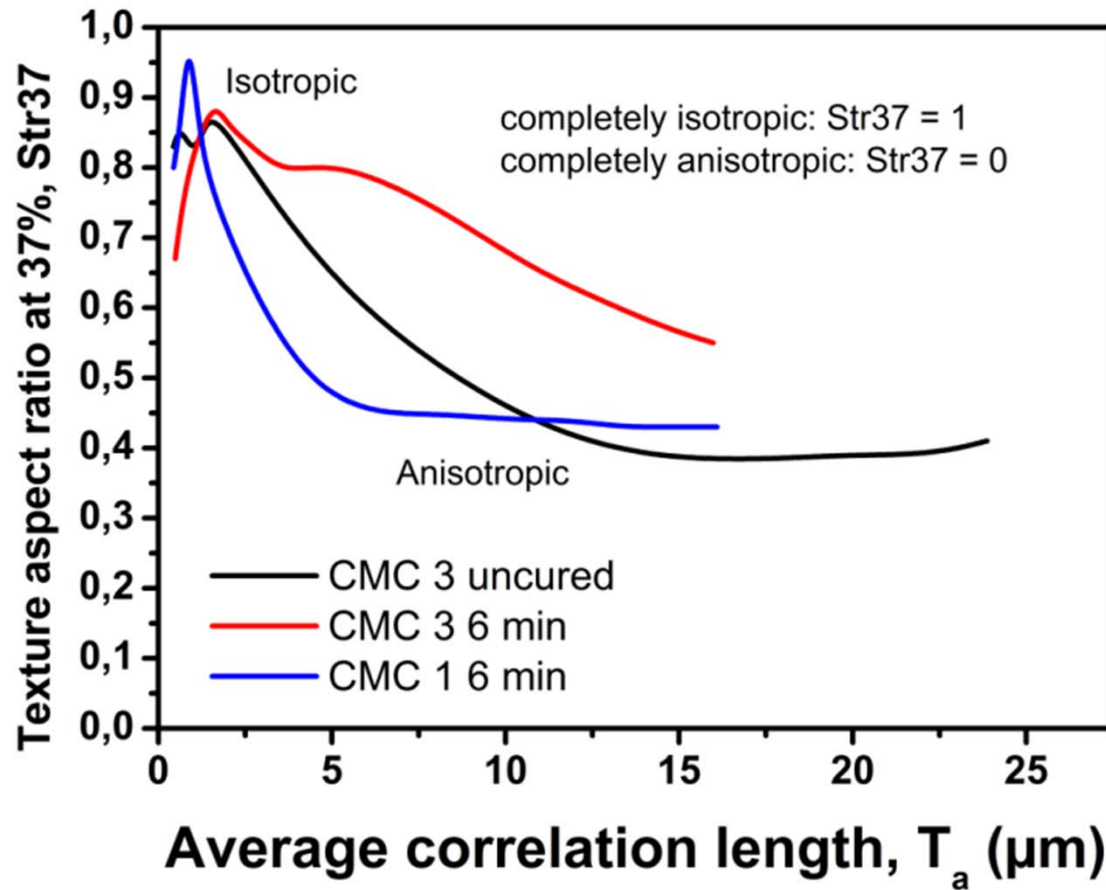


The effect of the curing time on colouring with the HEC films

A large scale atomic force microscopy topographical image ( $100\ \mu\text{m} \times 100\ \mu\text{m}$ ) of the surface of HEC-GGM with 2% or CA and no curing

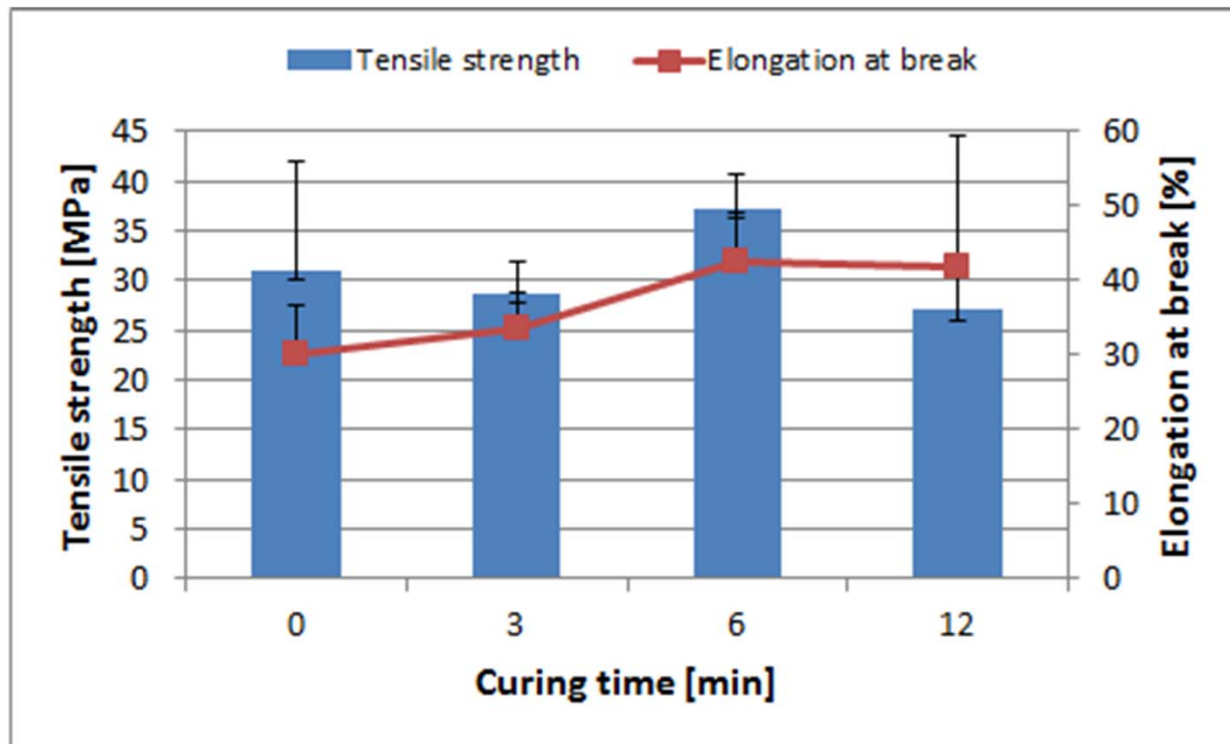


Small scale ( $5\ \mu\text{m} \times 5\ \mu\text{m}$ ) atomic force microscopy (AFM) topographs of (a) CMC-GGM film with 4% of citric acid and no curing,



- ✓ **Texture aspect ratio** (i.e. the surface layer) as a function of correlation length (i.e. lateral spacing of dominant height features) calculated from large scale ( $100 \mu\text{m} \times 100 \mu\text{m}$ ) atomic force microscopy images. *Each film shows deterministic texture direction at larger length scales*

- ✓ Curing enhances the mechanical properties



- ✓ Contact angle  $90^\circ$  as best
-

## Conclusion

The (continuing) study have shown the high potential of the citric acid reinforced biocomposite films for the food packaging applications.

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