



HAL
open science

Doping feruloylated arabinoxylan covalent hydrogels with cellulose nanocrystals

Carole Antoine-Assor, Martin In, Céline Moreau, Valérie Micard, Denis
Cassan

► To cite this version:

Carole Antoine-Assor, Martin In, Céline Moreau, Valérie Micard, Denis Cassan. Doping feruloylated arabinoxylan covalent hydrogels with cellulose nanocrystals. Journées scientifiques GDR SLAMM, Nov 2024, Le Croisic (FR), France. hal-04791099

HAL Id: hal-04791099

<https://hal.inrae.fr/hal-04791099v1>

Submitted on 19 Nov 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Doping feruloylated arabinoxylan covalent hydrogels with cellulose nanocrystals



Carole Assor Antoine ^{(1)*}, Martin In ⁽²⁾, Denis Cassan ⁽¹⁾, Céline Moreau ⁽³⁾ and Valérie Micard ⁽¹⁾

⁽¹⁾ Univ. Montpellier, INRAE, Institut Agro, U.M.R. IATE, Montpellier, France; ⁽²⁾ L2C, Univ. Montpellier, CNRS, Montpellier, France; ⁽³⁾ UR1268 Biopolymères Interactions Assemblages, INRAE, 44316 Nantes, France.

*carole.assor@inrae.fr

CONTEXT



WHEAT

1 T
milling process



FLOUR

French milling process
4.7 Mt of wheat in 2022



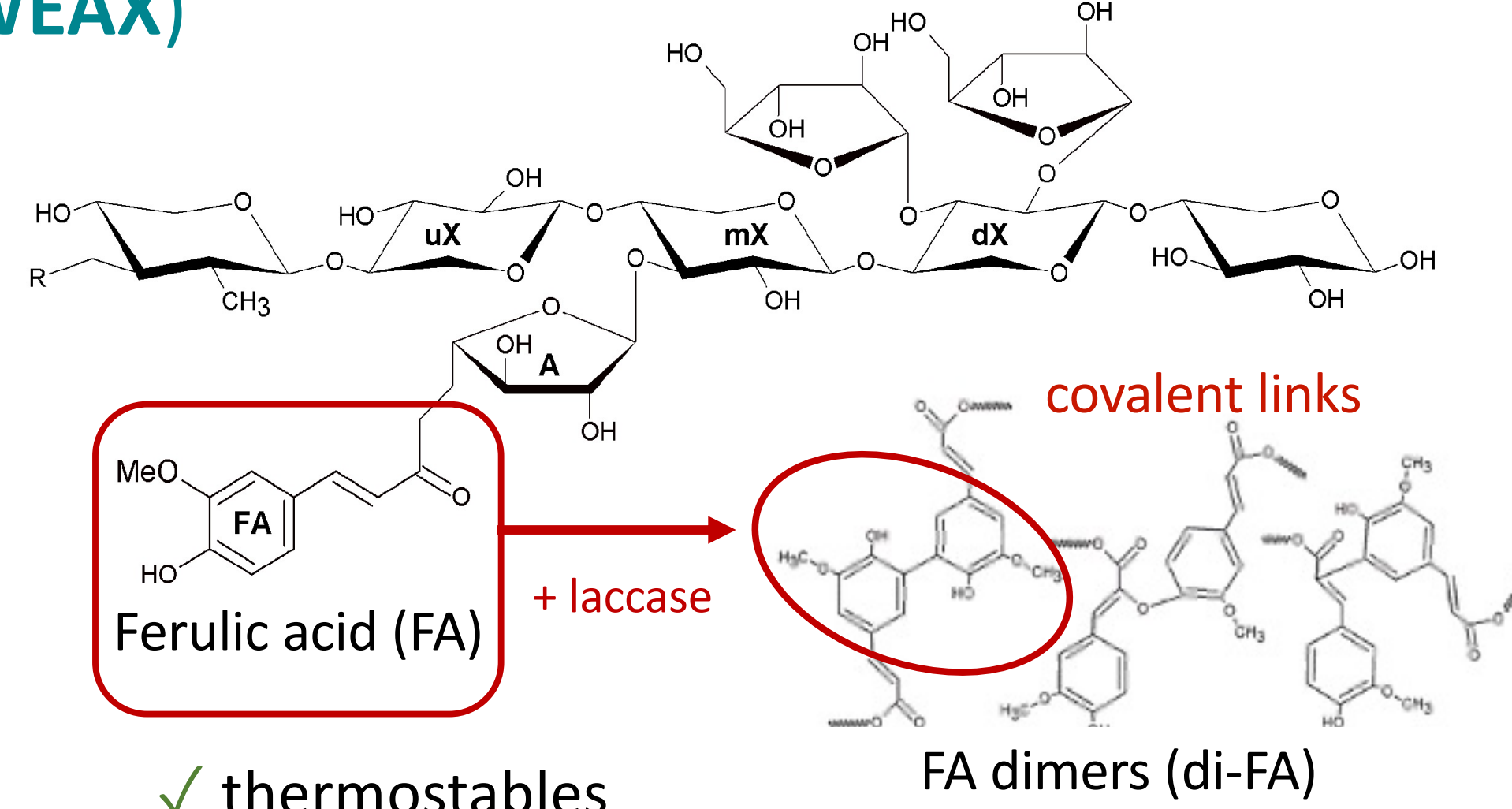
BRANS

0.25 T



covalent hydrogel

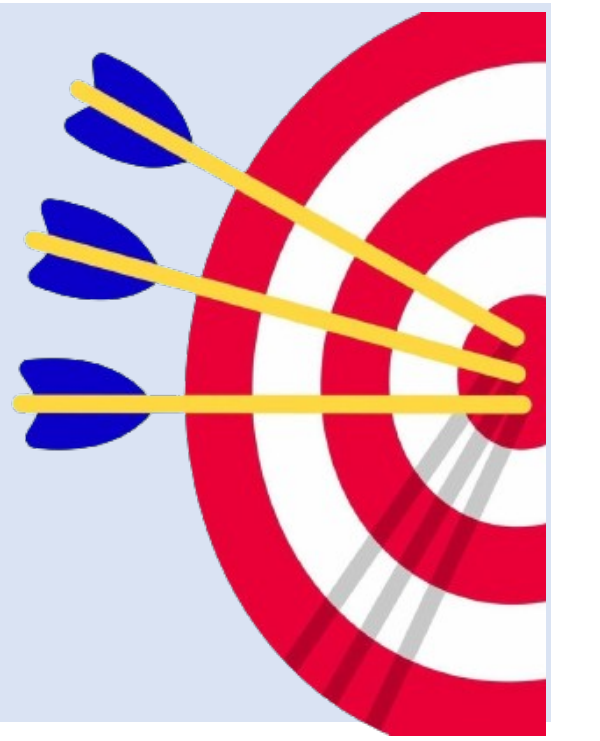
Feruloylated Water-Extractable Arabinoxylans (F-WEAX)



- ✓ thermostables
- ✓ swelling capacity (100 - 300 g water. g⁻¹ F-WEAX)
- ✓ stability/ pH
- ✓ macroporous : 200 - 500 nm for bioactive molecule encapsulation
- ✓ resistant to digestive enzymes
- ✗ mechanical (from 10 to 100 Pa)

AIM OF THE STUDY

Improvement of mechanical strength of F-WEAX covalent gel by addition of cellulose nano crystals (CNC) combining two networks, a covalent and a reinforced physical one

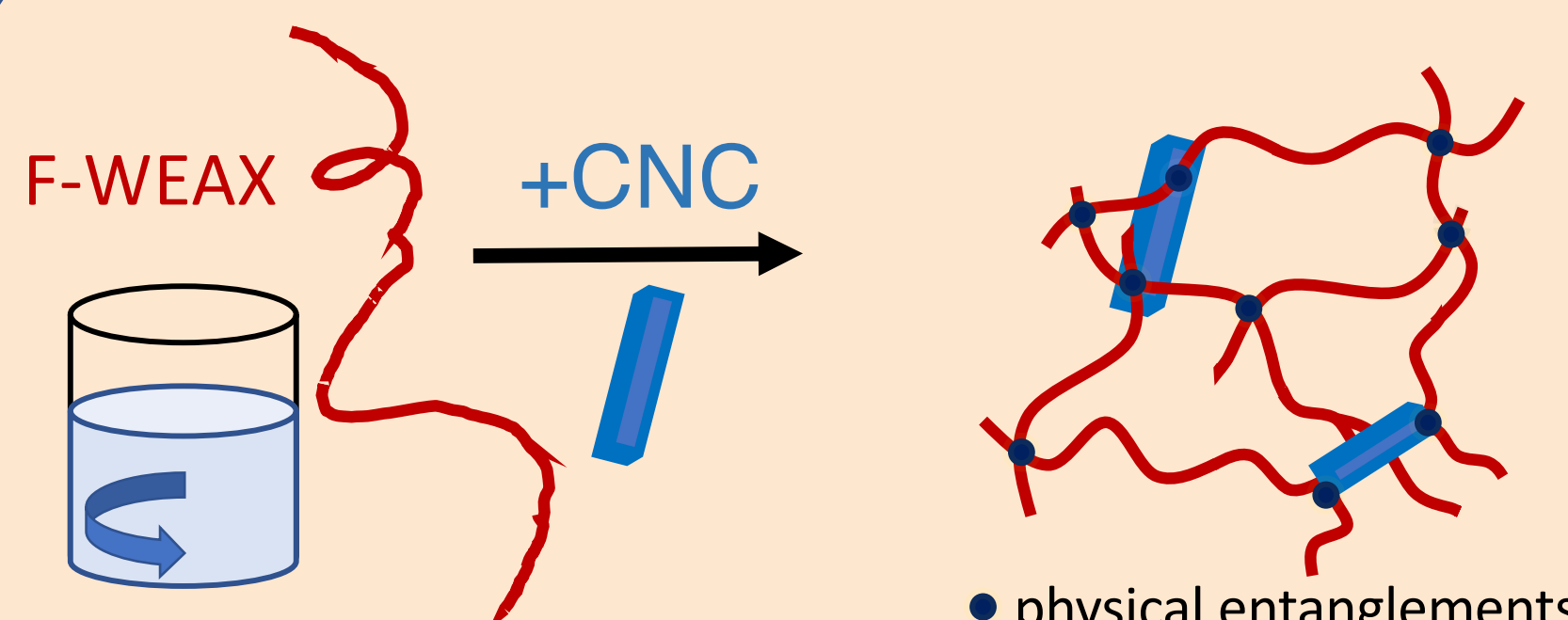


HYPOTHESIS

- strong physical interactions between CNC and F-WEAX
- CNC content modulate viscoelastic and structural properties of the mixed gels
- preservation of gel swelling capacity

EXPERIMENTAL STRATEGY

MIXED SUSPENSIONS



F-WEAX solution: 20 g.L⁻¹
+ CNC suspension: 0 to 15 g.L⁻¹
+ strong mechanical stirring

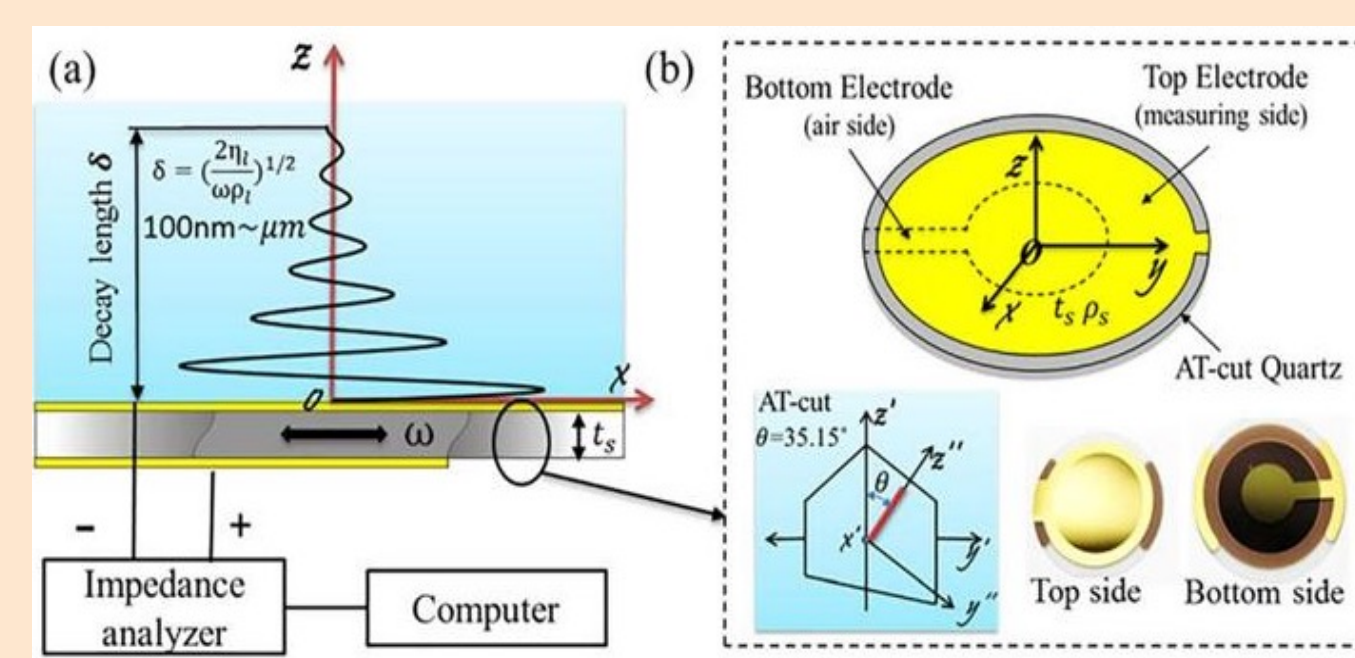
F-WEAX content: 10 g.L⁻¹
CNC/ F-WEAX ratio:
0; 0.5; 1; 1.5

Molecular properties

F-WEAX

A/X : 0.58
AF : 1.61 microg. mg⁻¹ F-WEAX
Purity : 63 %
M_w : 438 kDa
approximately 1258 xyloses
R_g : 600 Å

F-WEAX/ CNC interactions



Quartz Micro Balance (QCM)

+ laccase ⁽²⁾

CNC

2.3 - 4.5 nm (AFM)
44 -108 nm
~ 81-200 glucoses ⁽¹⁾
R_g = 202 (70/(√12)) = 202 Å

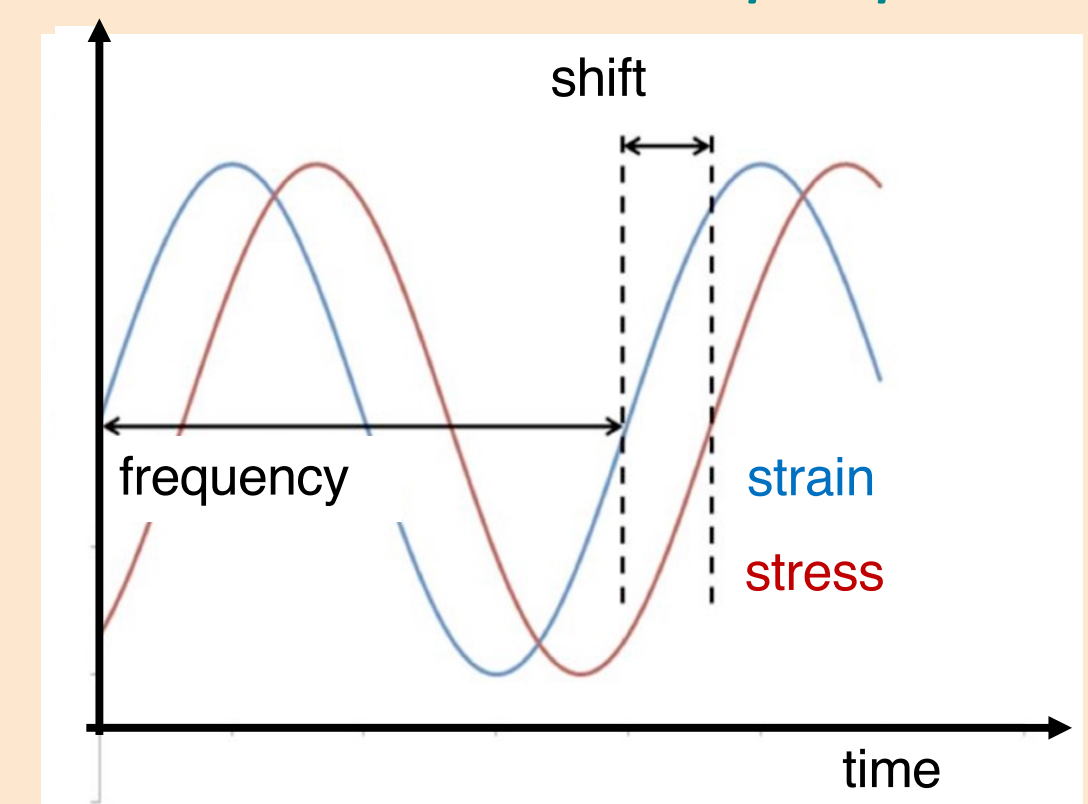
⁽¹⁾ Reid et al., Langmuir 2017, 33, 1583-1598.

MIXED GELS

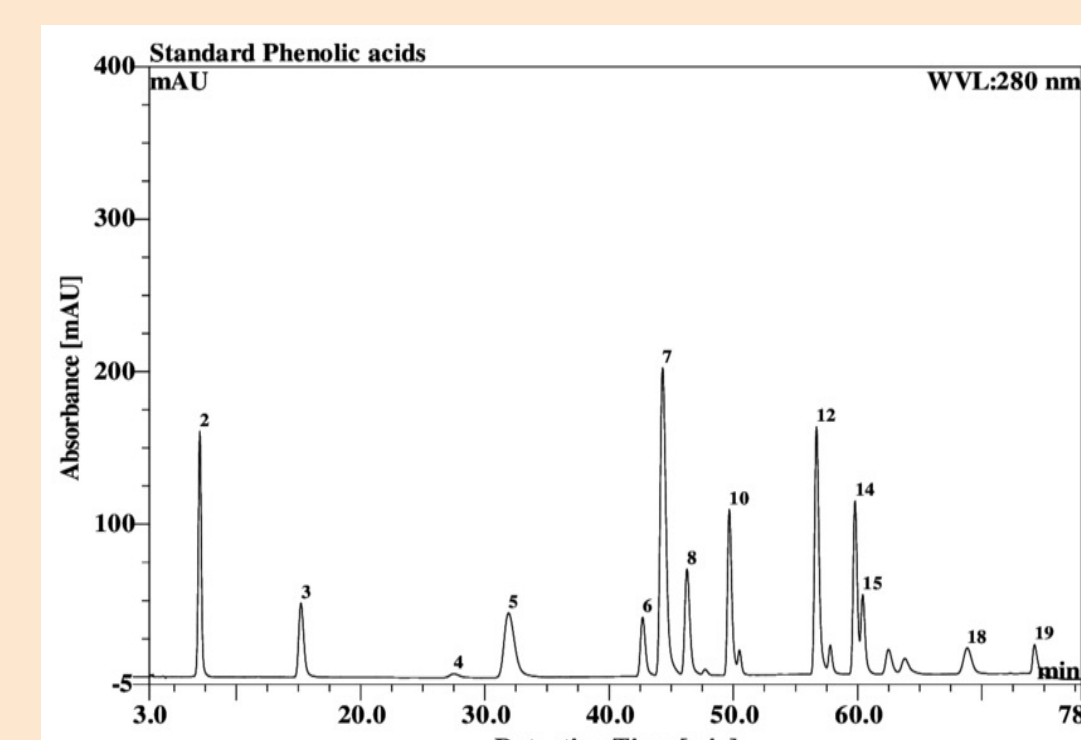
enzymatic gelation



Viscoelastic properties

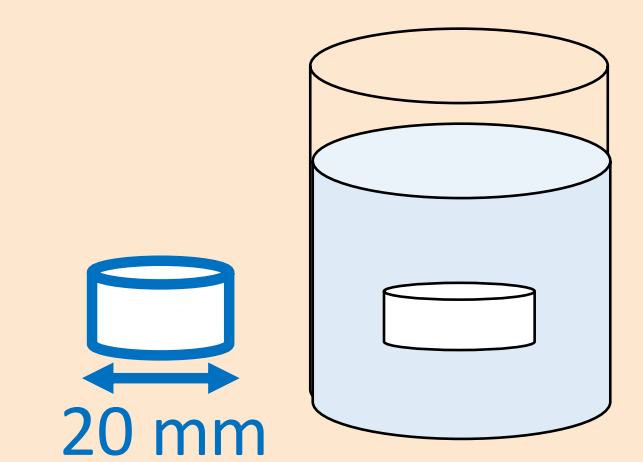


Structural properties



FA; di-FA contents
covalent cross-link density

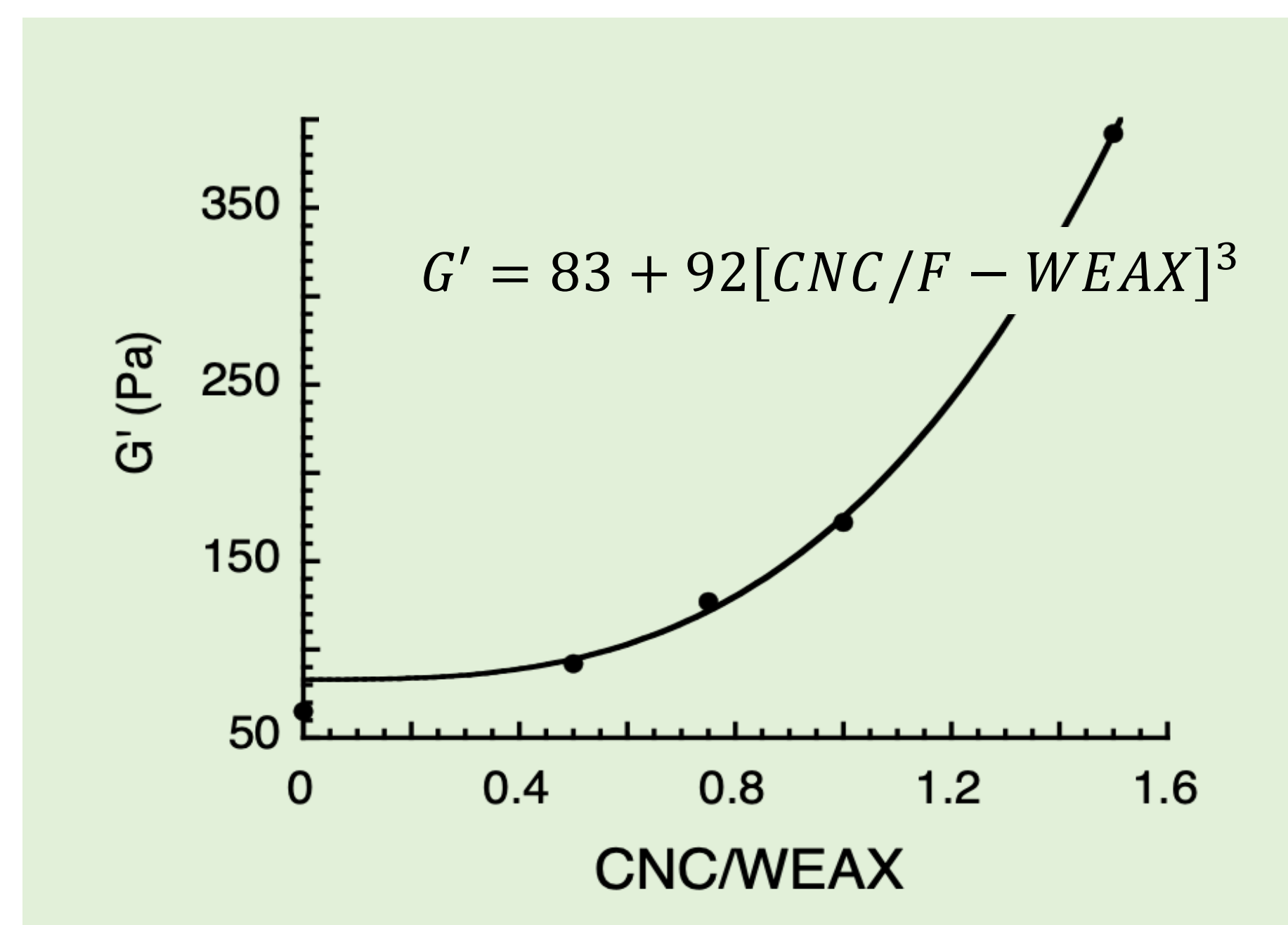
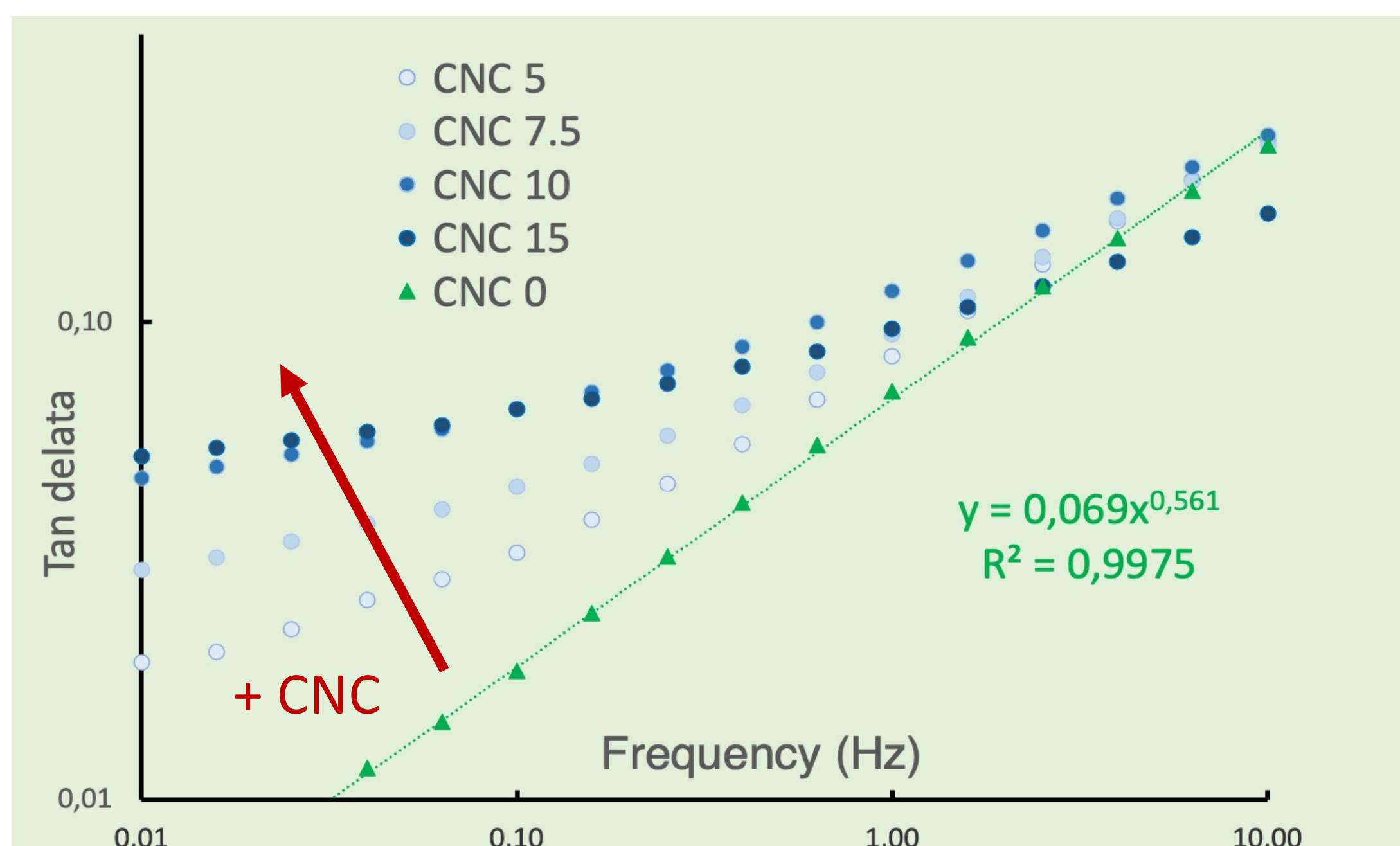
Swelling capacity



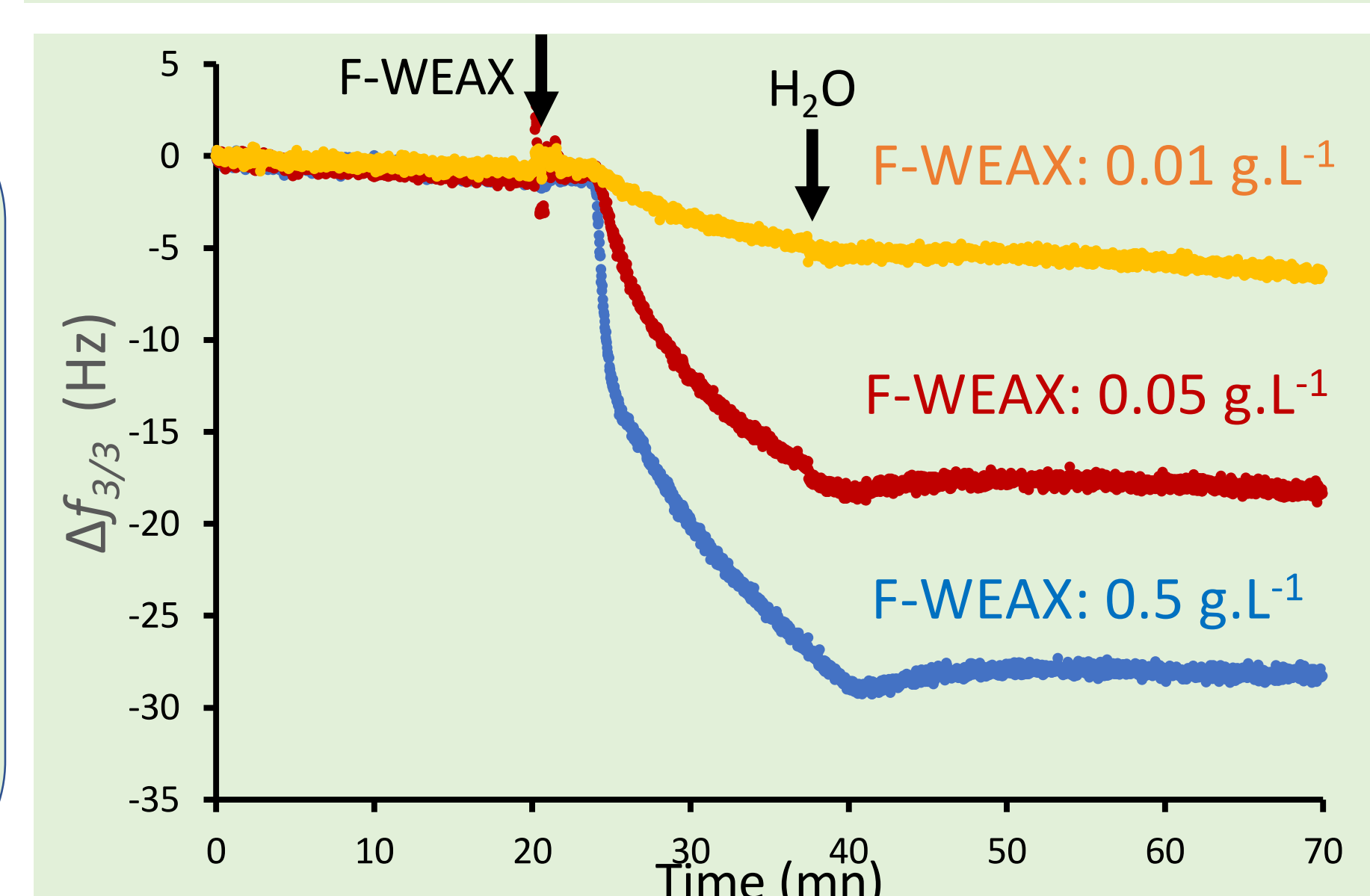
swelling equilibrium: H₂O + 0.02 % azide, 20 h, 20°C

$$q = (W_s - W_{F-WEAX}) / W_{F-WEAX}$$

RESULTS



| CNC/ F-WEAX ratio | FA oxidized % | di-FA μg. mg ⁻¹ F-WEAX | FA recovered % | q g H2O. g ⁻¹ F-WEAX |
|-------------------|---------------|-----------------------------------|----------------|---------------------------------|
| 0.00 | 92 ± 1 | 0.44 ± 0.04 | 25 ± 2 | 199 ± 00 |
| 0.50 | 85 ± 1 | 0.72 ± 0.04 | 48 ± 2 | 123 ± 14 |
| 0.75 | 83 ± 3 | 0.80 ± 0.03 | 55 ± 1 | 124 ± 12 |
| 1.00 | 76 ± 7 | 0.74 ± 0.02 | 54 ± 4 | 121 ± 09 |
| 1.50 | 75 ± 6 | 0.73 ± 0.07 | 56 ± 9 | 134 ± 05 |



CONCLUSIONS

- F-WEAX interact strongly and irreversibly with CNC surfaces
- after gelation, % of FA recovered under di-FA forms is two times higher in presence of CNC
- G' and G'' increase with CNC/ F-WEAX ratio with a cubic power law
- swelling capacity of mixed gels is link to its covalent crosslink density

Structural model of CNC/ F-WEAX association

