Mechanical Properties of Cork : Effect of Hydration

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Mechanical properties of cork: effect of hydration

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Context

The use of cork as sealing for wine bottles is due to its low permeability to liquids and gases, imputrescibility and good mechanical properties, in particular its remarkable elasticity [1-2].

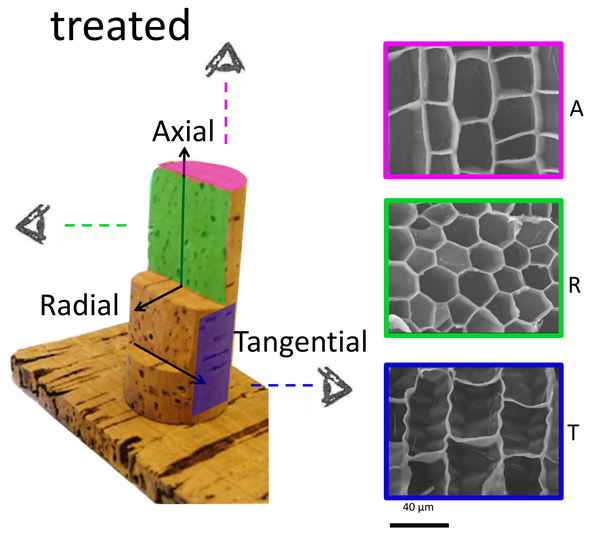
Objectives

- To determine mechanical properties of cork along the radial and tangential directions (which corresponds to the compression in a bottleneck)
- To study the effect of hydration on mechanical properties of cork

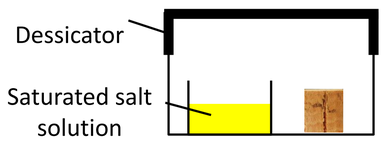
Materials & Methods

Cork

- Species: *Quercus suber L.*
- Origin: Portugal
- High quality (class 0)
- neither washed nor surface treated

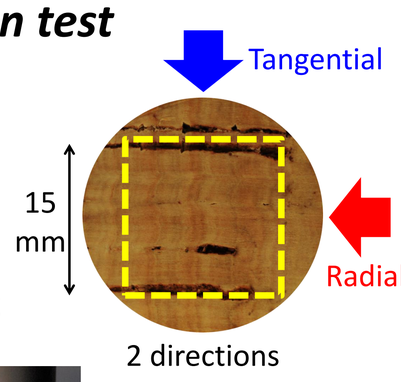


Sample preparation

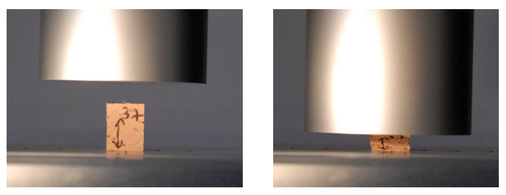


RH from 0 to 100 %
T = 25°C
Equilibration time ≈ 4 months

Compression test

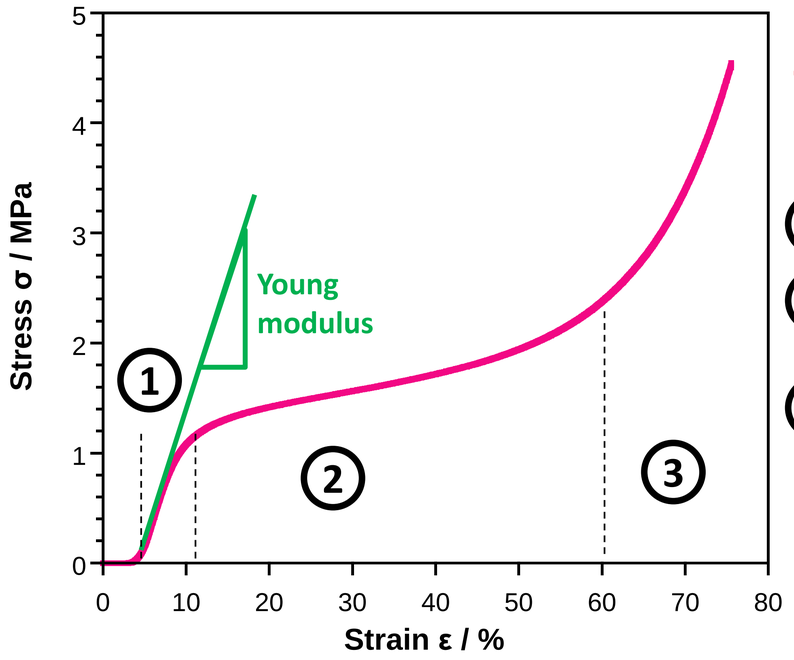


TA-HD+
Deformation: 80 %
Test speed: 1 mm/sec



Results

Cork under compression



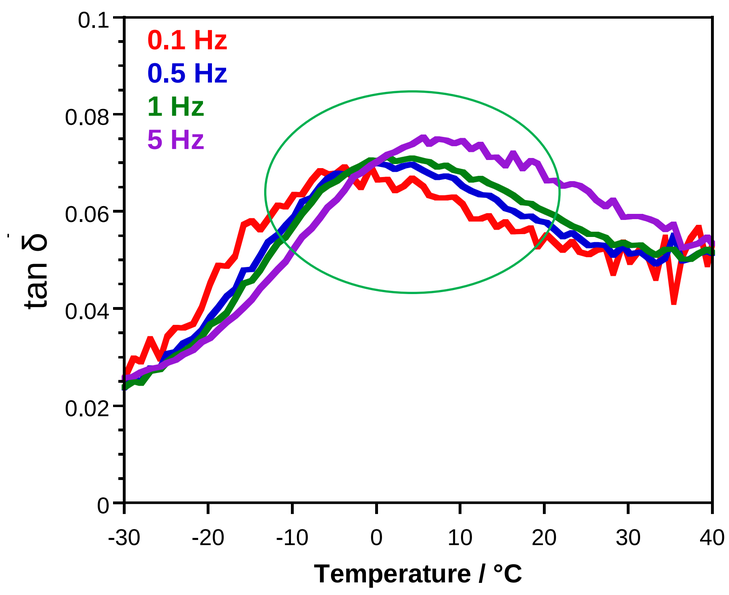
→ **strain/stress curve: 3 regions**

1. Elastic region
2. progressive buckling of cell walls
3. buckling of cell walls

Young modulus calculation

$$E = \frac{\sigma}{\varepsilon}$$

Dynamic mechanical analysis

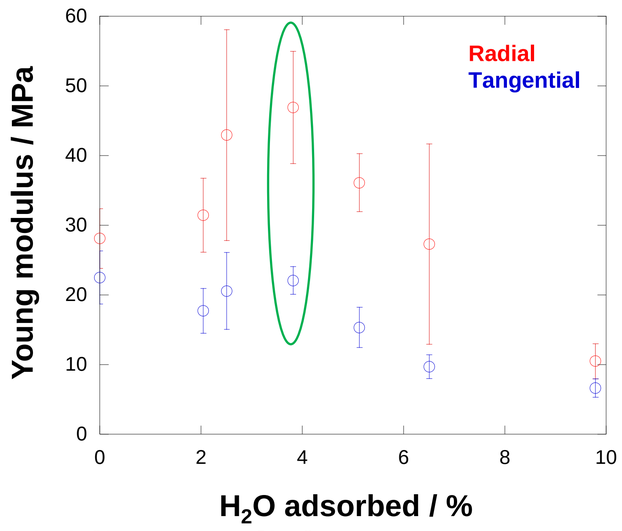


$$\tan\delta = \frac{G''}{G'}$$

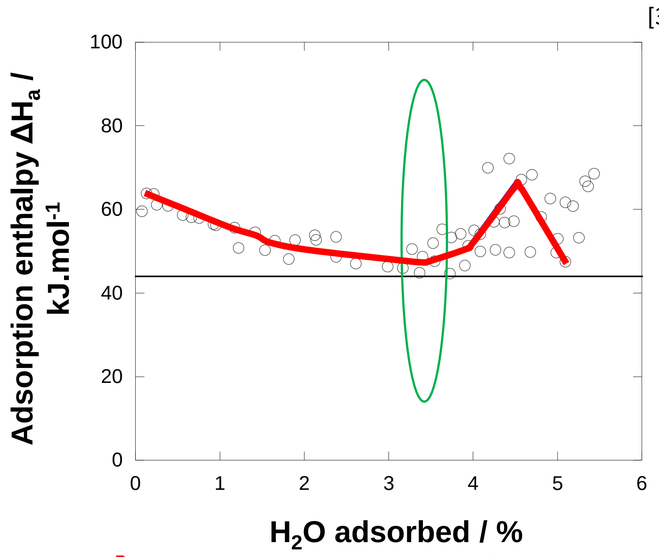
→ **Shift of tan δ for different frequencies: glass transition ?**

Water effect on Young modulus

[3]

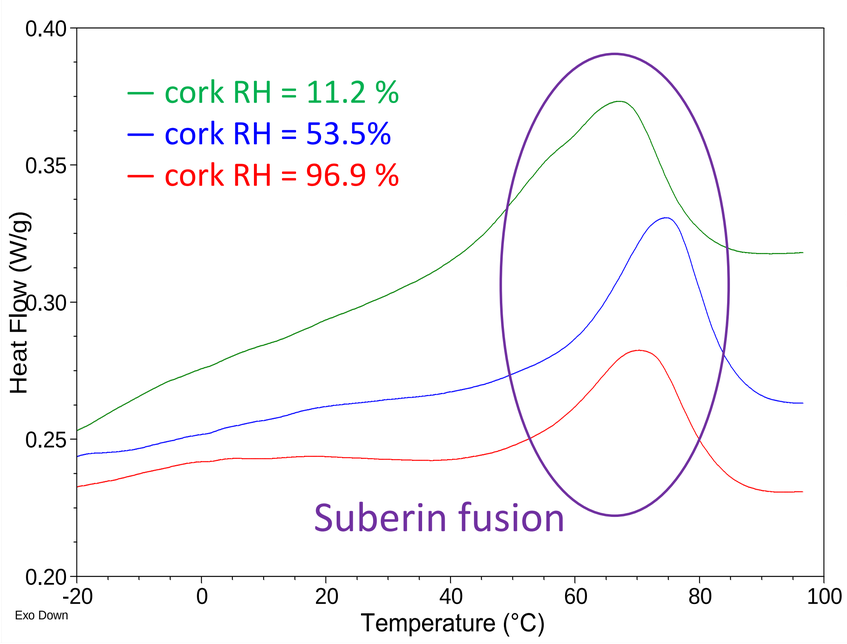


→**Rigidity: - radial > tangential**
- maximum for HR ≈ 50%



→ **Important role of water in cork structure**

Differential scanning calorimetry



→ **Difficult to identify a T_g**

Conclusion

Mechanical properties of cork depend on relative humidity. Water plays an important role in cork structure with an antiplasticizing effect below 4 wt % water content, and then a plasticizing effect above this value. This can be explained by the existence of an amorphous fraction in cork which goes across its glass transition withtin this relative humidity range.

References

[1] Mano, J.F. 2002. The viscoelastic properties of cork. Journal of Membrane Science. 37(2), 257-263.
[2] Karbowiak, T., Gougeon, R.D., Alinc, J-B., Brachais, L., Debeaufort, F., Voilley, A., Chassagne, D., (2010). Wine oxidation and the role of cork. *Crit. Rev. Food. Sci.*, 50, 20-52
[3]Lequin, S., Chassagne, D., Karbowiak, T., Gougeon, R. g., Brachais, L., & Bellat, J.-P. (2010). Adsorption Equilibria of Water Vapor on Cork. *Journal of Agricultural and Food Chemistry, 58*(6), 3438-3445.