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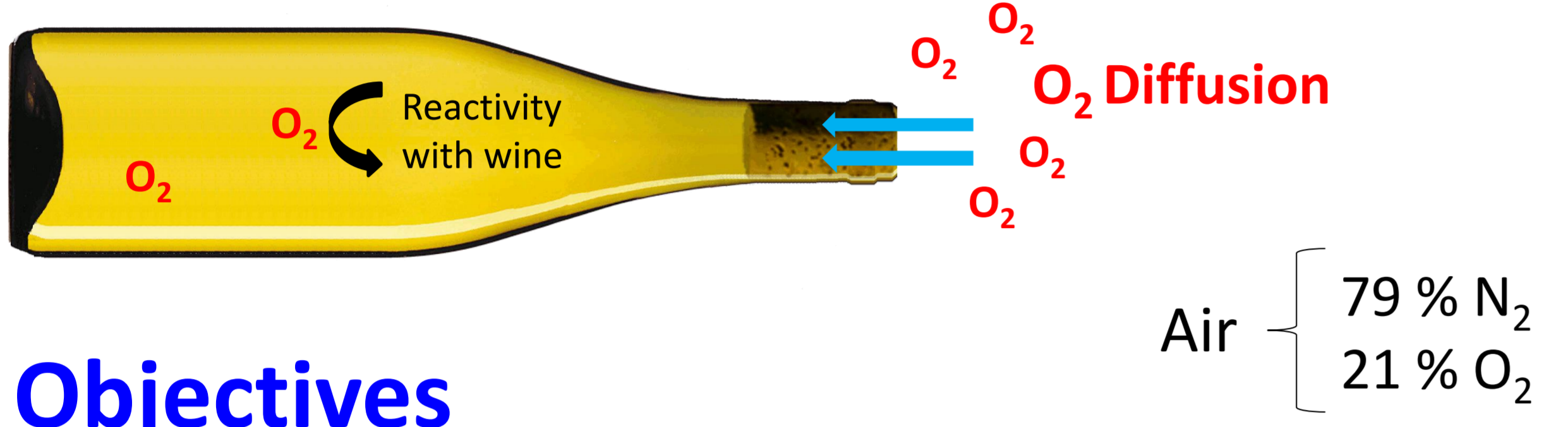
Diffusion mechanisms in cork

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Context

During post-bottling aging, oxygen transfer through the stopper occurs and can lead to oxidation reactions [1]. When in excess, a final result of such reactions is color change (browning) and off-flavor appearance, which modifies the organoleptic properties of the wine.



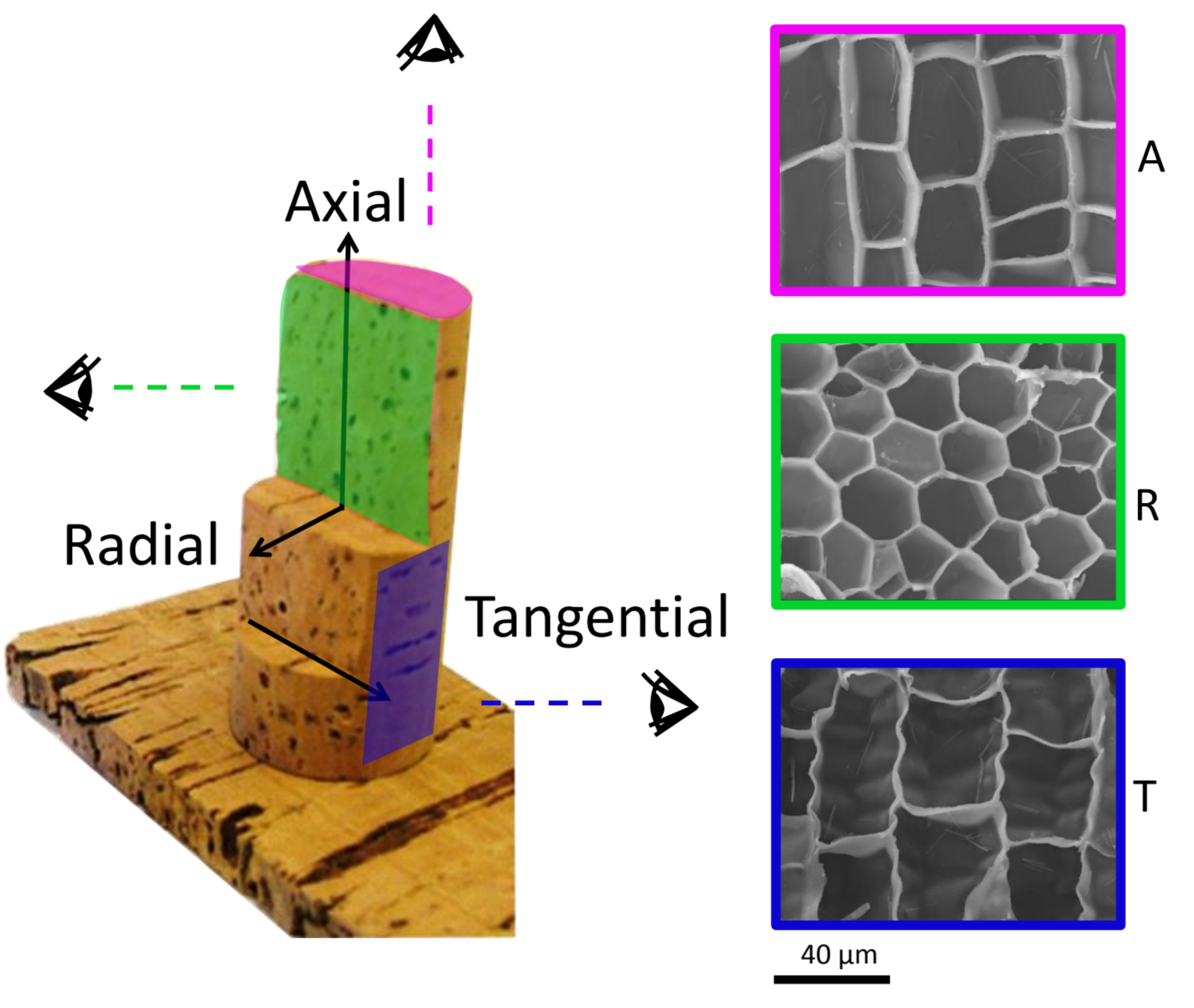
Objectives

- To investigate the internal structure of cork stopper
- To clearly identify the limiting step of the oxygen transport through the cork stopper

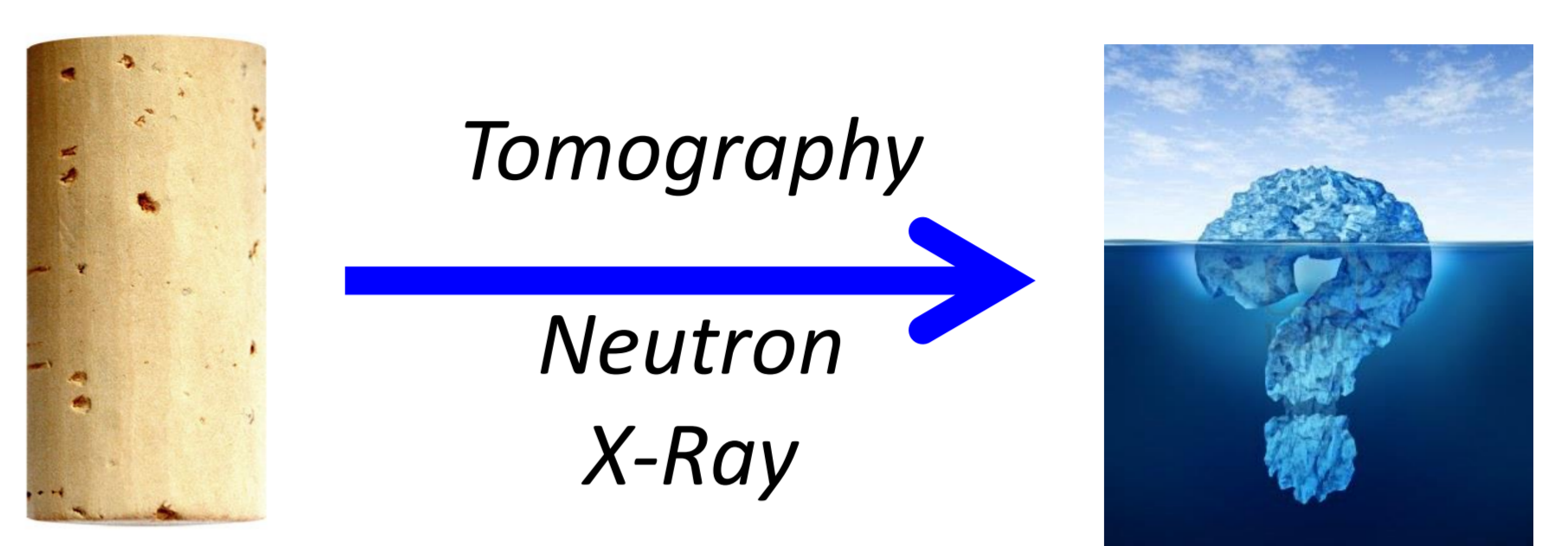
Materials & Methods

Cork

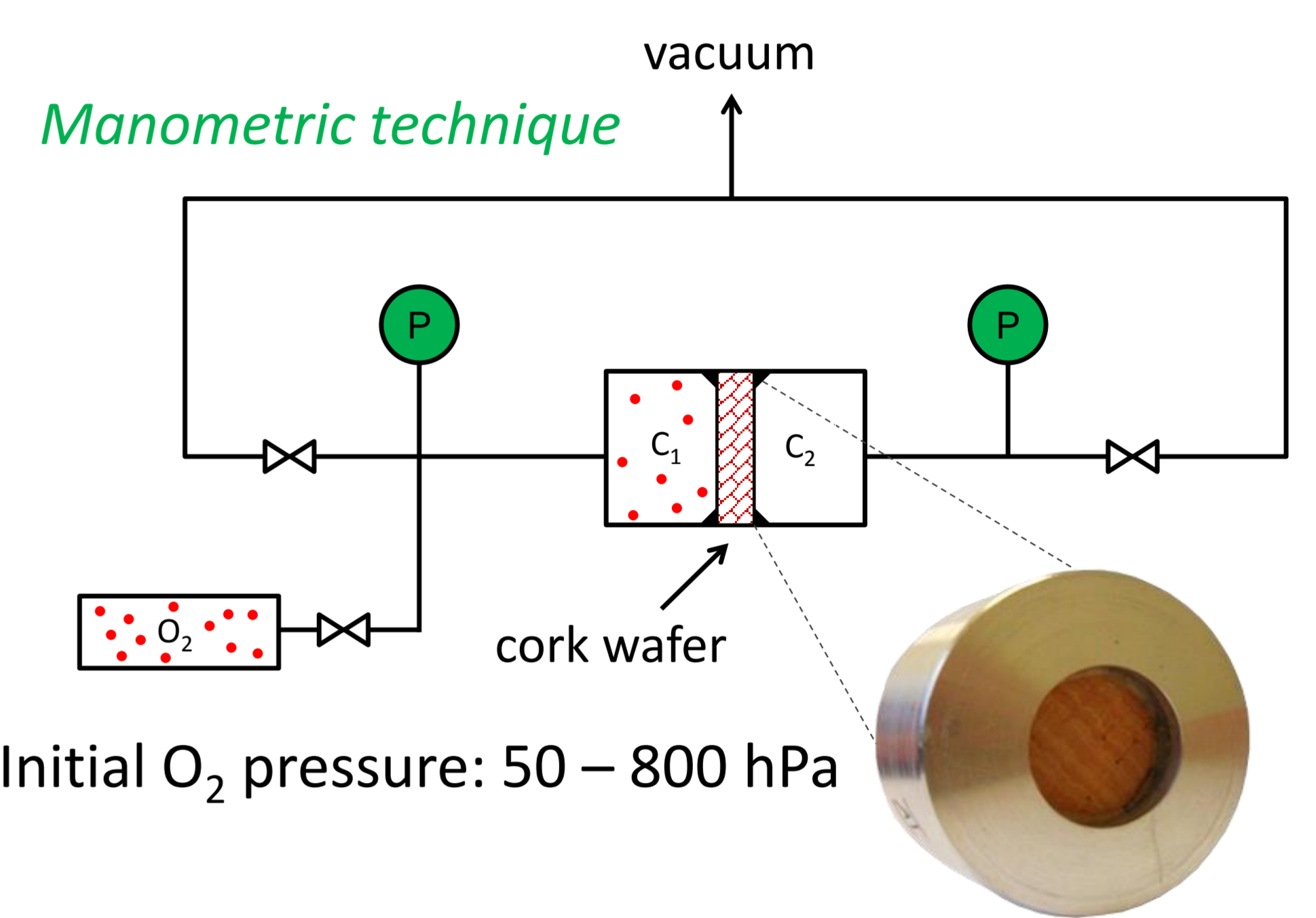
- Species: *Quercus suber* L.
- Origin: Portugal
- High quality (class 0)
- neither washed nor surface treated



Characterisation of internal porosity

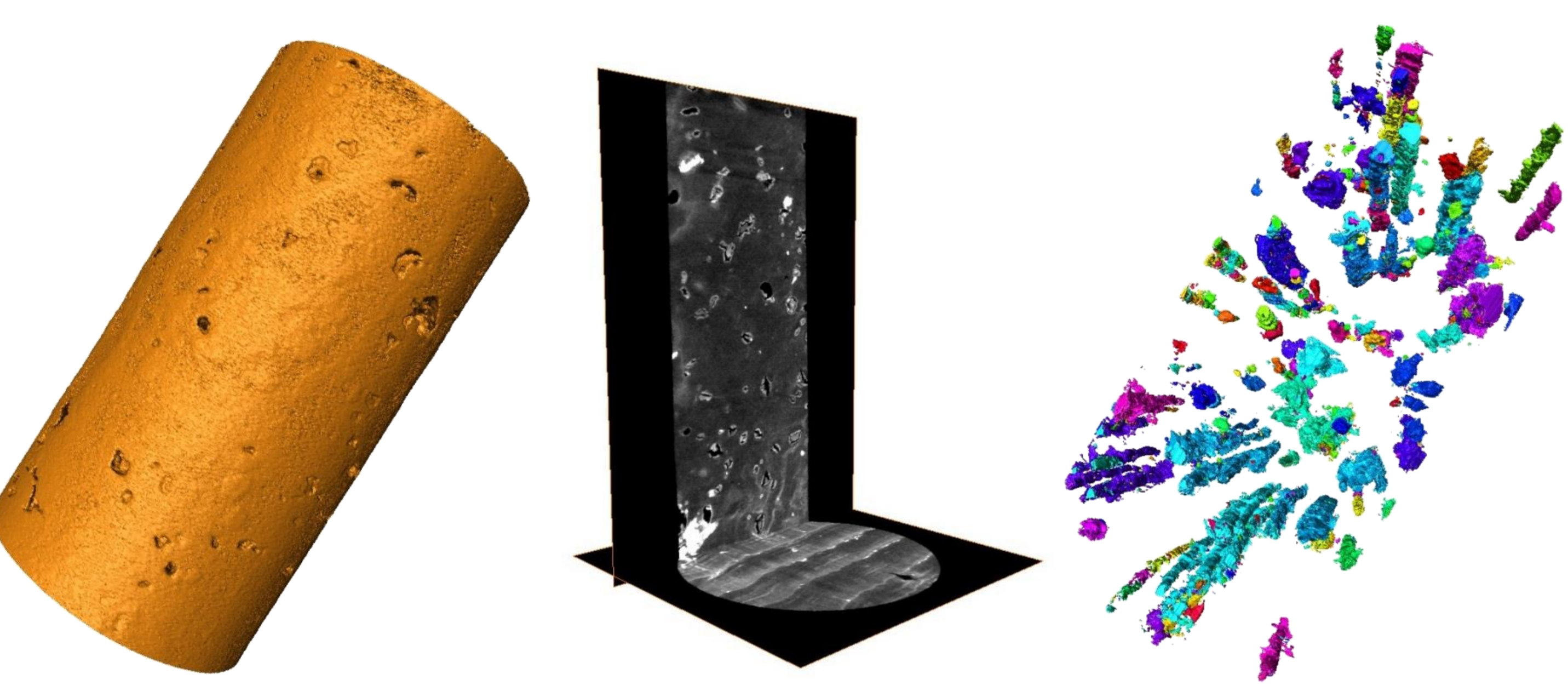


Permeation of oxygen [2]



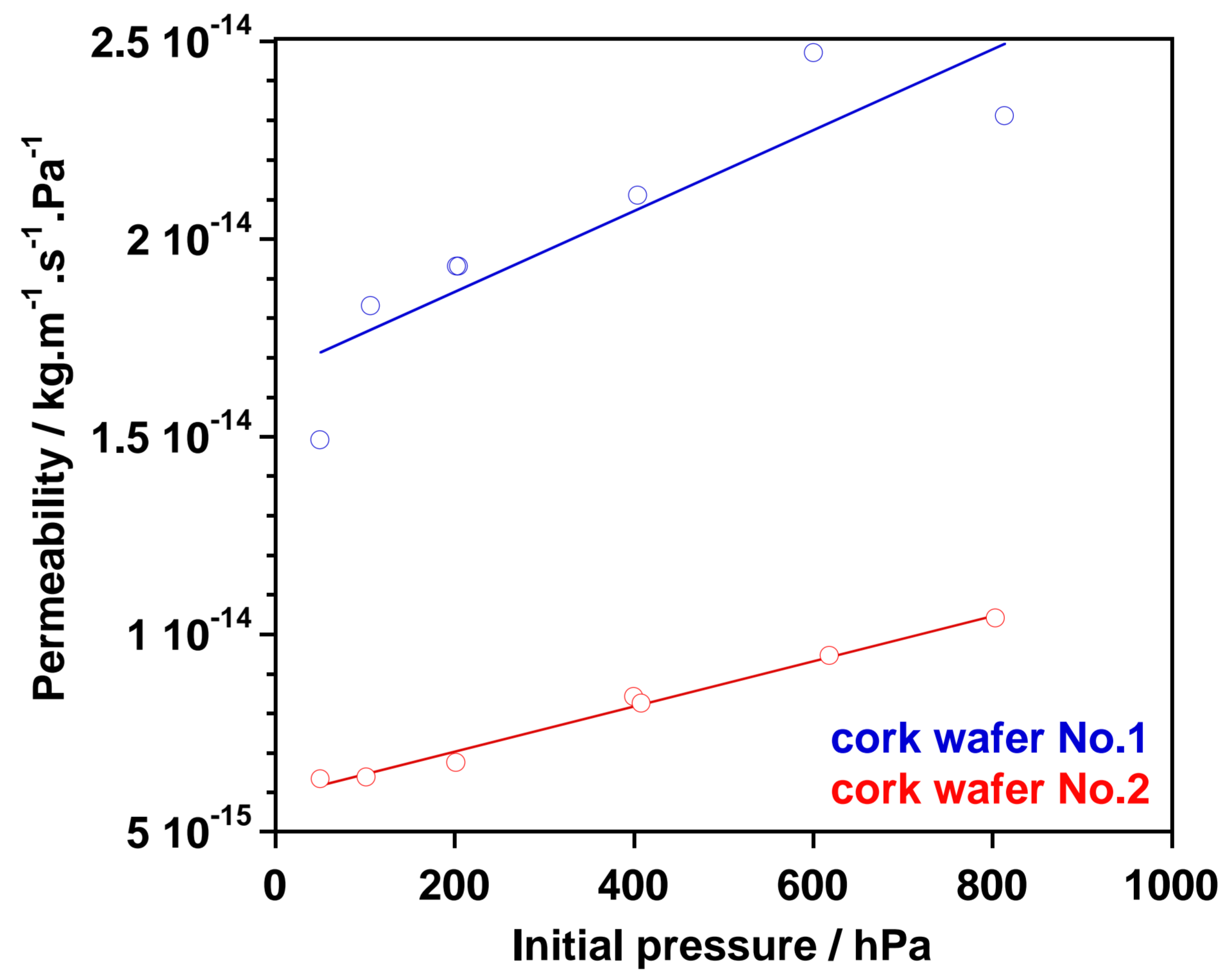
Results

Internal structure of cork



- No interconnectivity between lenticels [3]
- Gas molecules must go through a dense phase (cork cells)

Determination of the limiting step

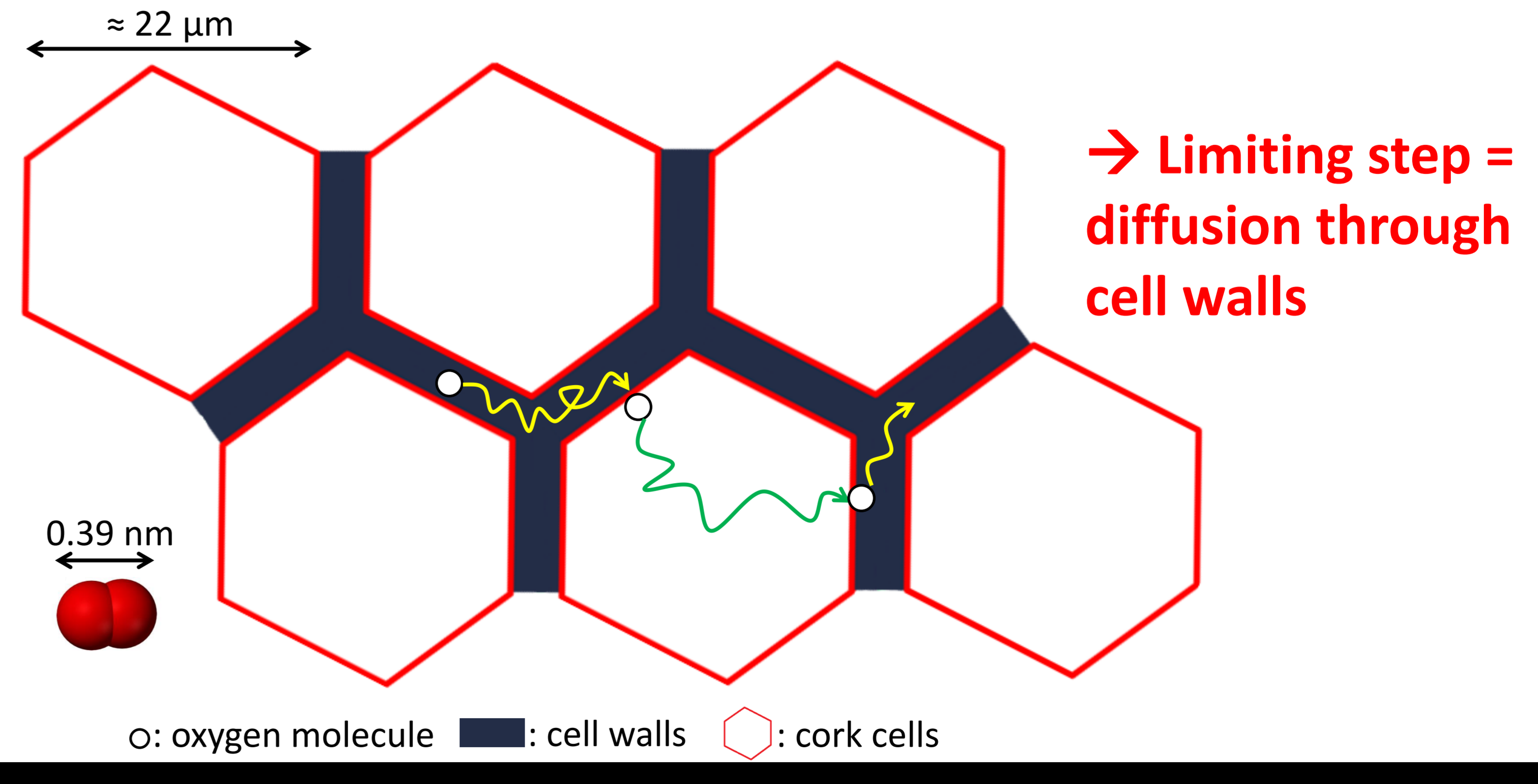


Knudsen $P_K = \frac{d}{3} \sqrt{\frac{8M}{RT}}$

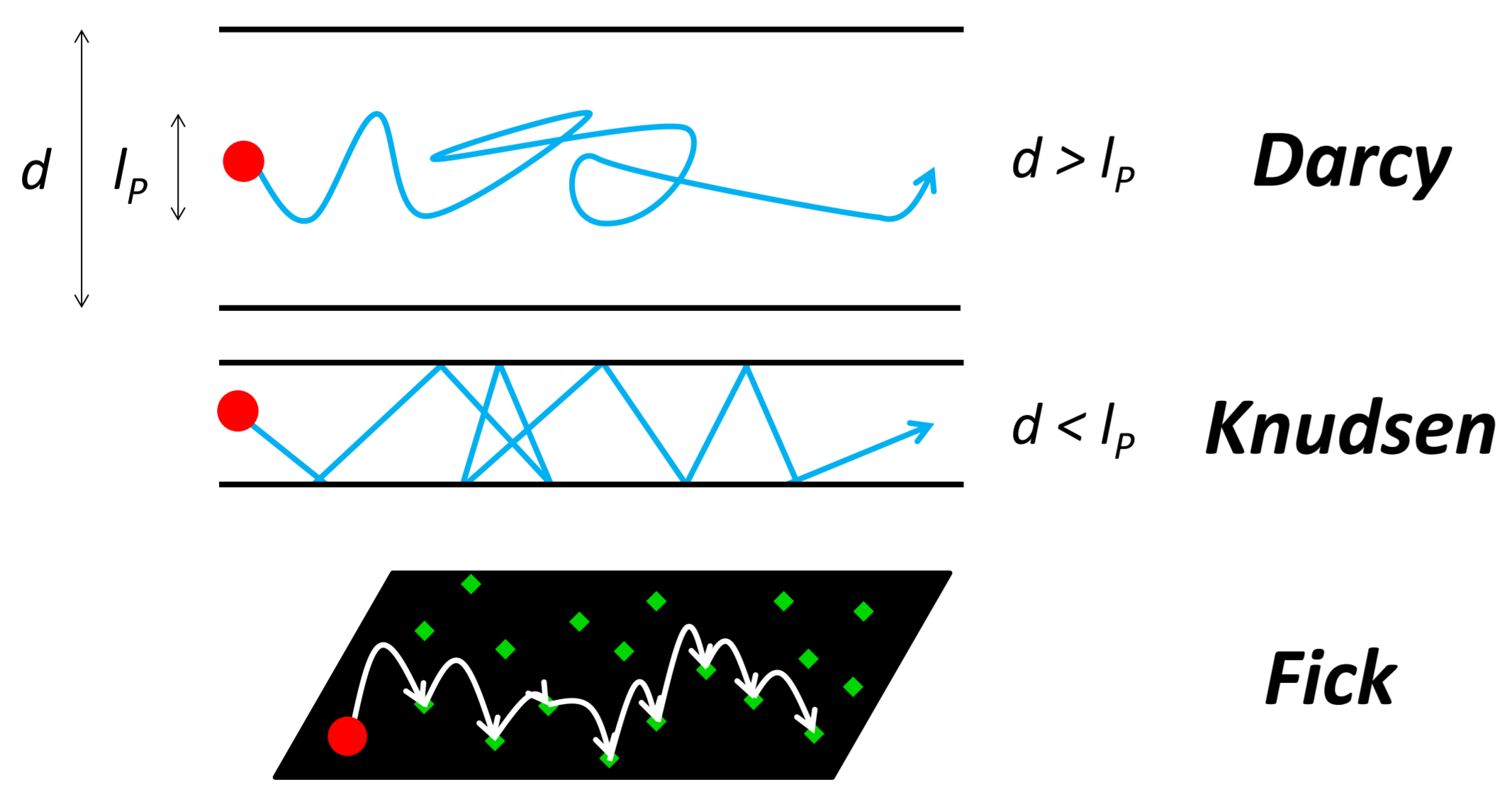
Fick $P_F = \frac{DC_a M}{p}$

→ Fickian mechanism = limiting step [4]

Diffusion mechanism in cork



Transport mechanisms



Conclusion

Imaging experiments showed that there is no interconnectivity between lenticels. According to this internal structure, gas molecules not only reside in lenticels but must go through a dense phase to cross the material. The limiting step of gas transfer in cork is the diffusion of molecules through the cell walls according to a Fickian mechanism.

References

[1] Karbowski, 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

[2] Lequin, S., Chassagne, D., Karbowski, T., Simon, J. M., Paulin, C., Bellat, J. P. (2012). Diffusion of oxygen in cork. *J. Agric. Food. Chem.*, 60 (13), 3348-3356.

[3] Lagorce-Tachon, A., Karbowski, T., Loupiac, C., Gaudry, A., Ott, F., Alba-Simionesco, C., Gougeon, R. D., Alcantara, V., Mannes, D., Kaestner, A., Lehmann, E., Bellat, J.-P. (2015). The cork viewed from the inside. *J. Food Eng.*, 149, 214-221.

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