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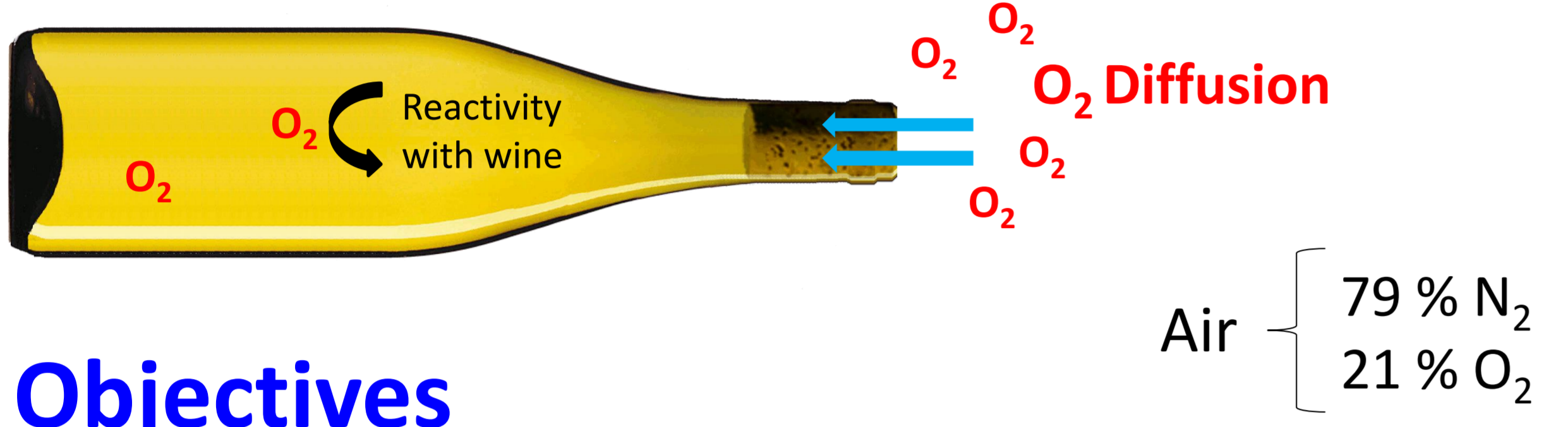
Diffusion mechanisms in cork

Aurélié LAGORCE-TACHON ^{a,b,c}, Thomas KARBOWIAK ^a, Camille LOUPIAC ^a,
Jean-Marc SIMON ^c, Régis GOUGEON ^{a,b} and Jean-Pierre BELLAT ^c

^a UMR PAM Équipe PAPC Agrosup Dijon, Université de Bourgogne Franche-Comté, 1 esplanade Erasme, F-21078 Dijon, France
^b Institut Universitaire de la Vigne et du Vin, Université de Bourgogne Franche-Comté, 1 rue Claude Ladrey, F-21078 Dijon, France
^c Laboratoire Interdisciplinaire Carnot de Bourgogne, UMR 6303 CNRS, Université de Bourgogne Franche-Comté, 9 avenue Alain Savary, B.P. 47870 F-21078 Dijon, France

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.



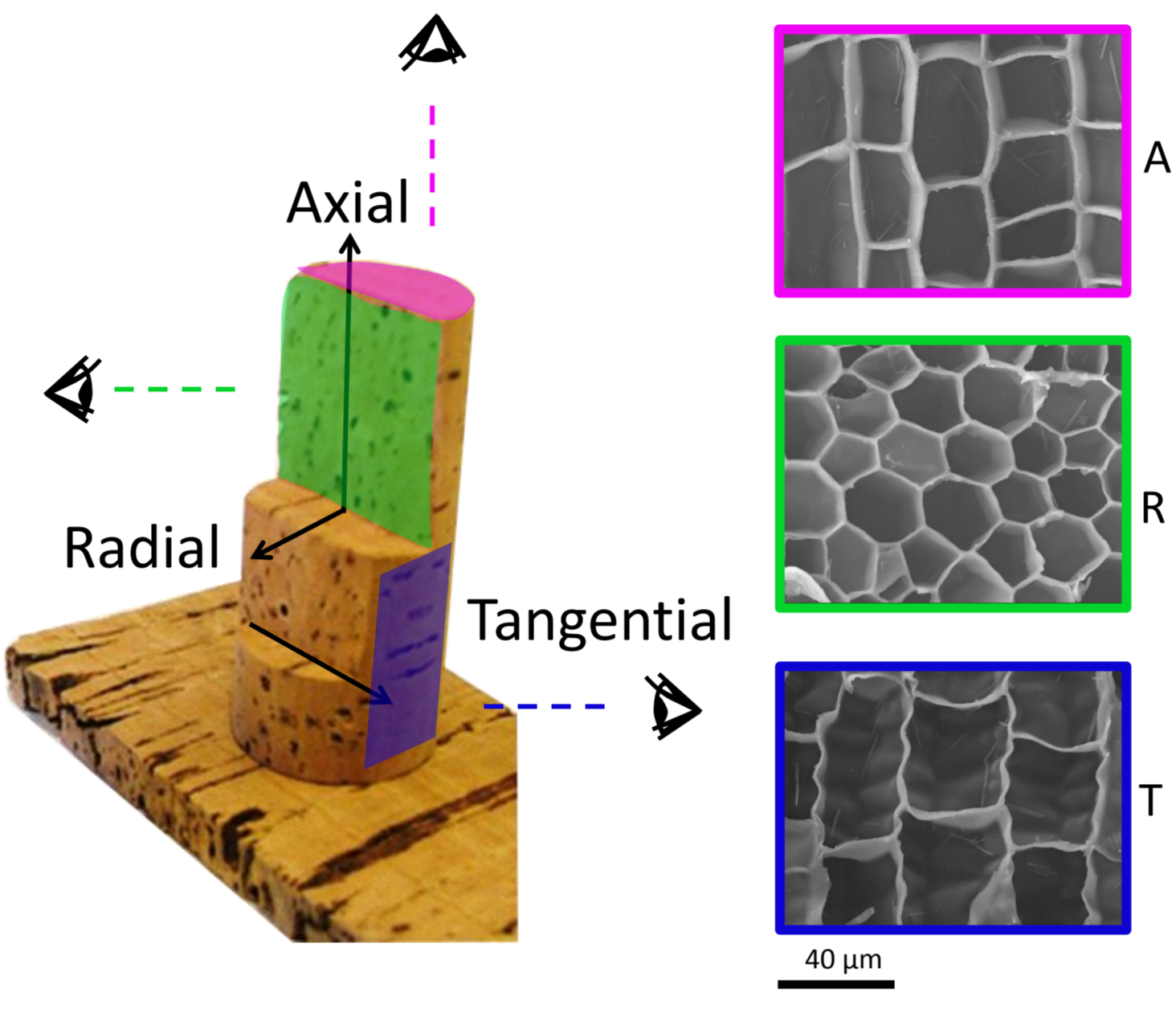
Objectives

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

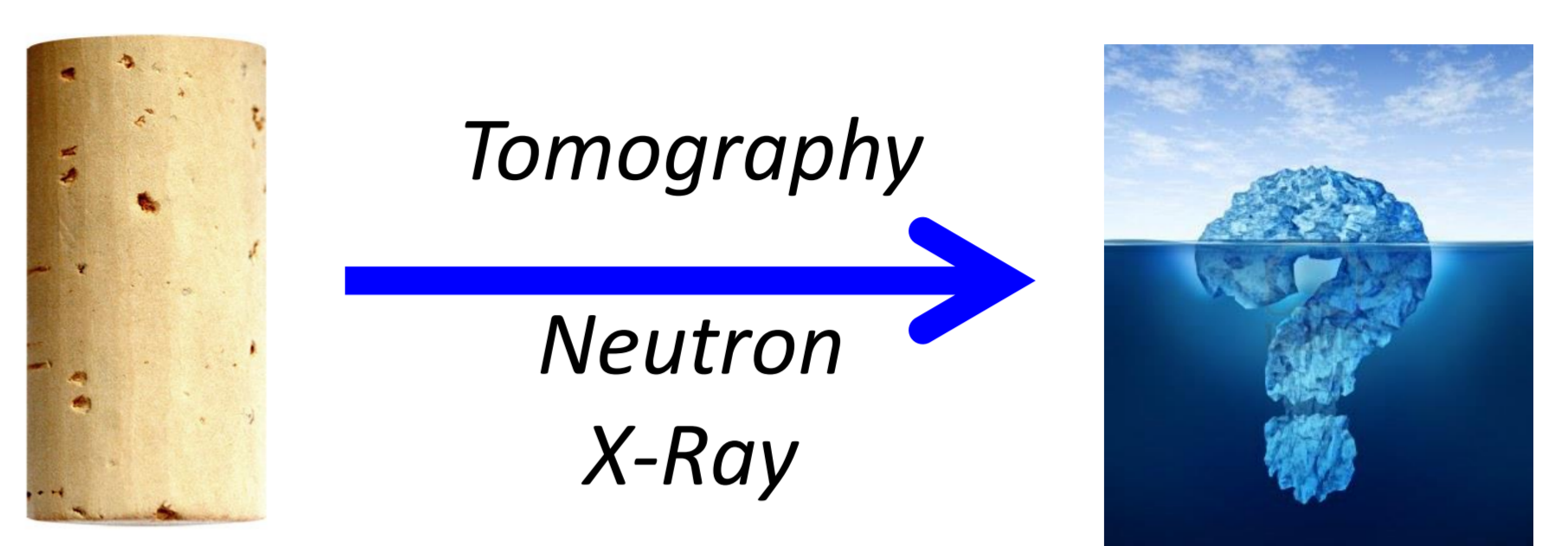
Materials & Methods

Cork

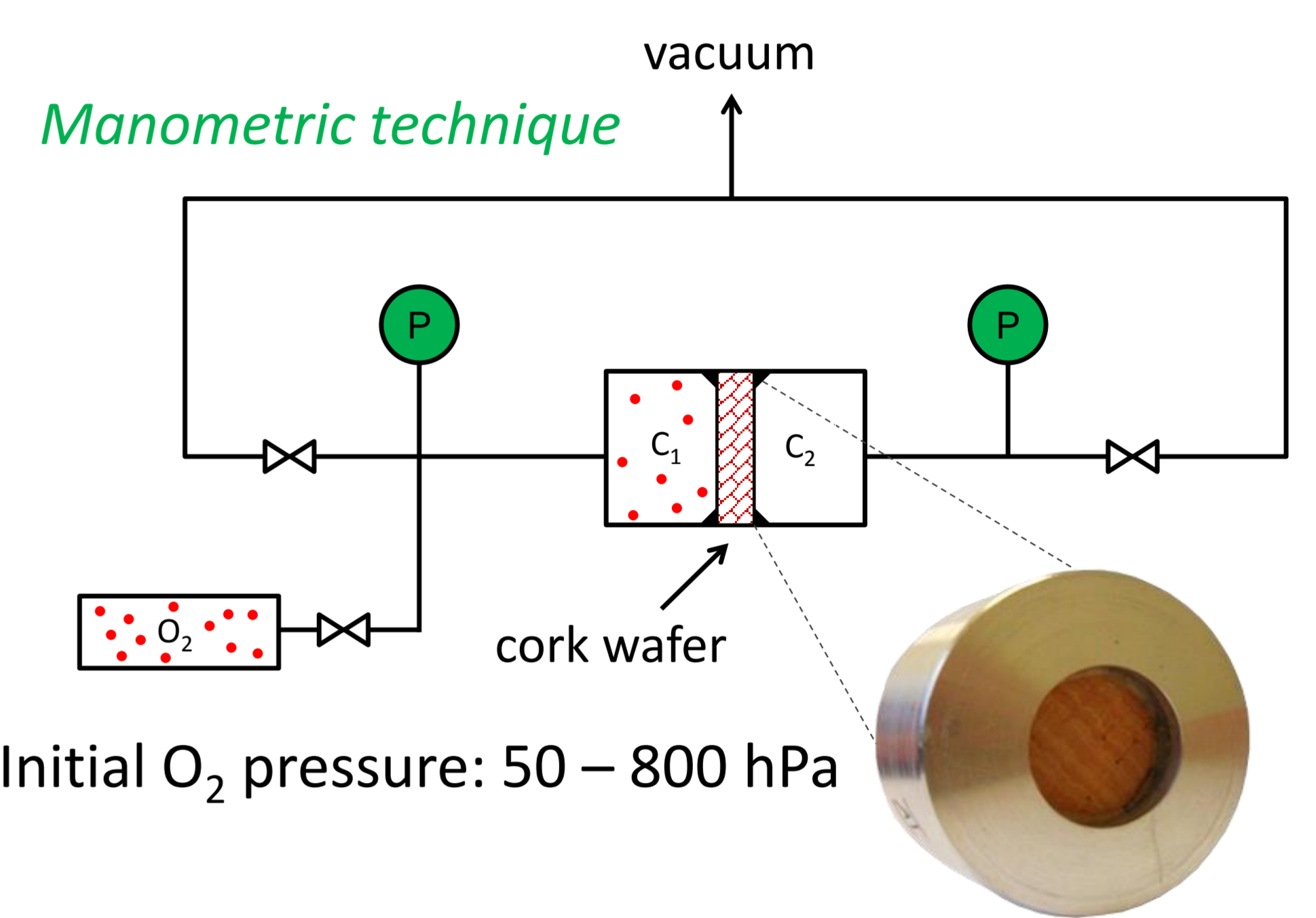
- Species: *Quercus suber* L.
- Origin: Portugal
- High quality (class 0)
- neither washed nor surface treated



Characterisation of internal porosity

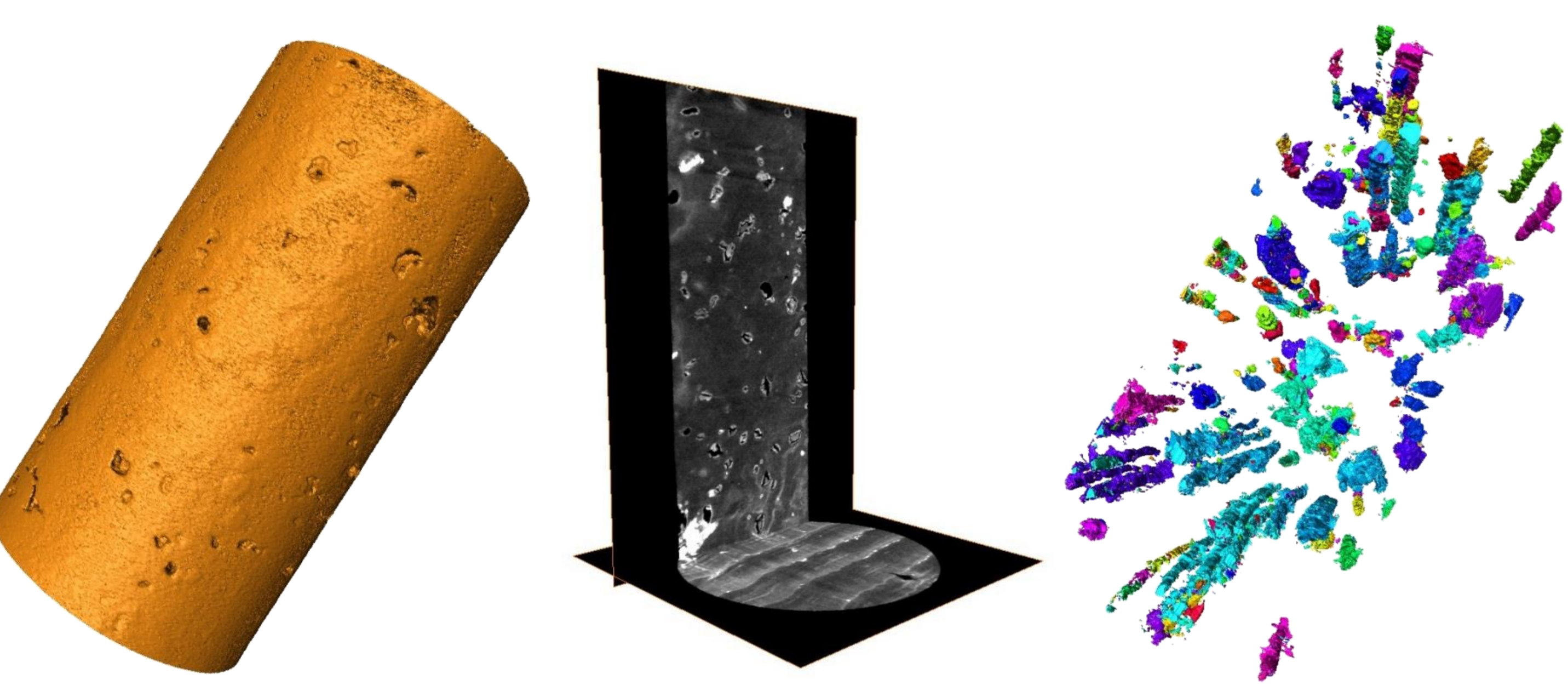


Permeation of oxygen [2]



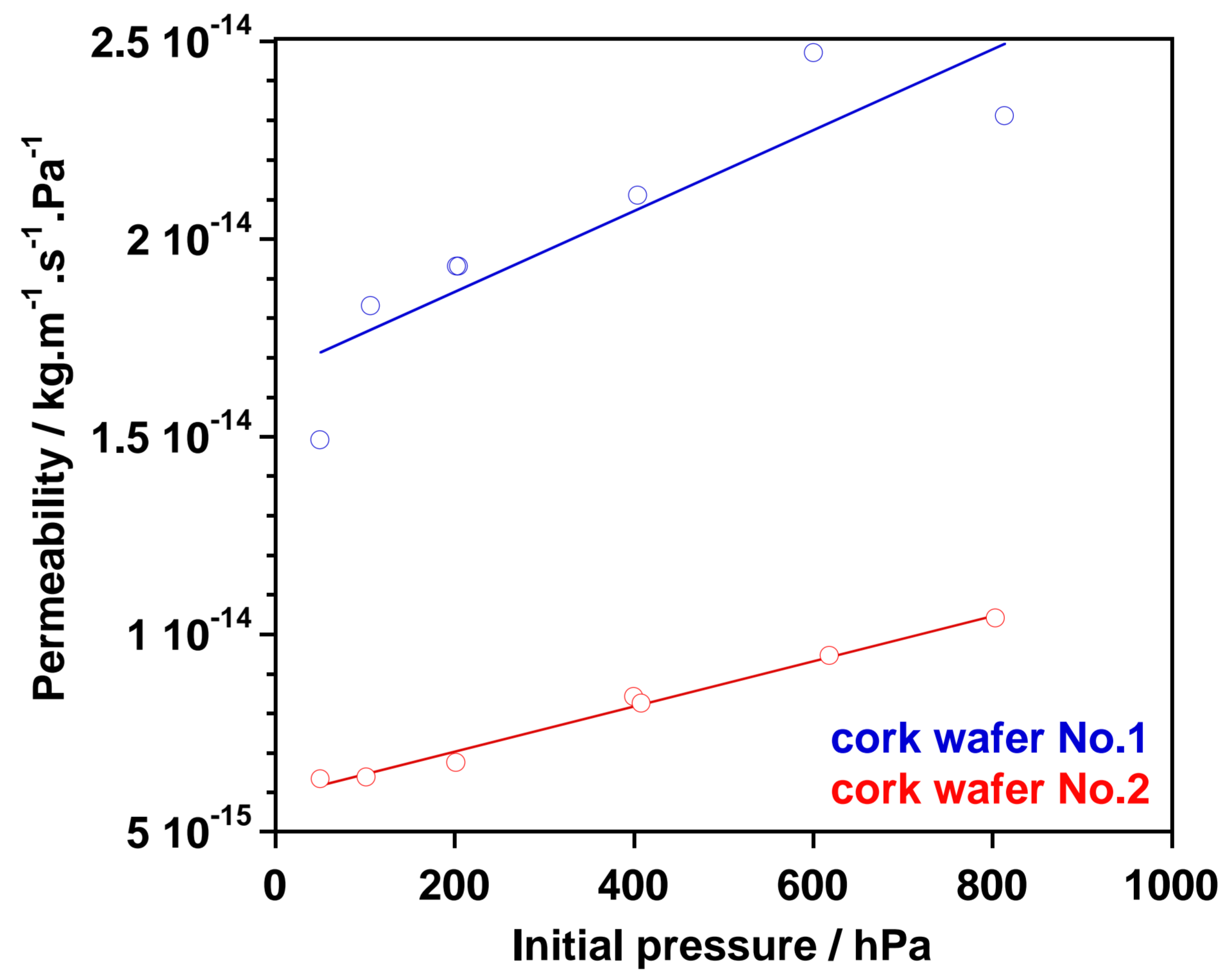
Results

Internal structure of cork



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

Determination of the limiting step

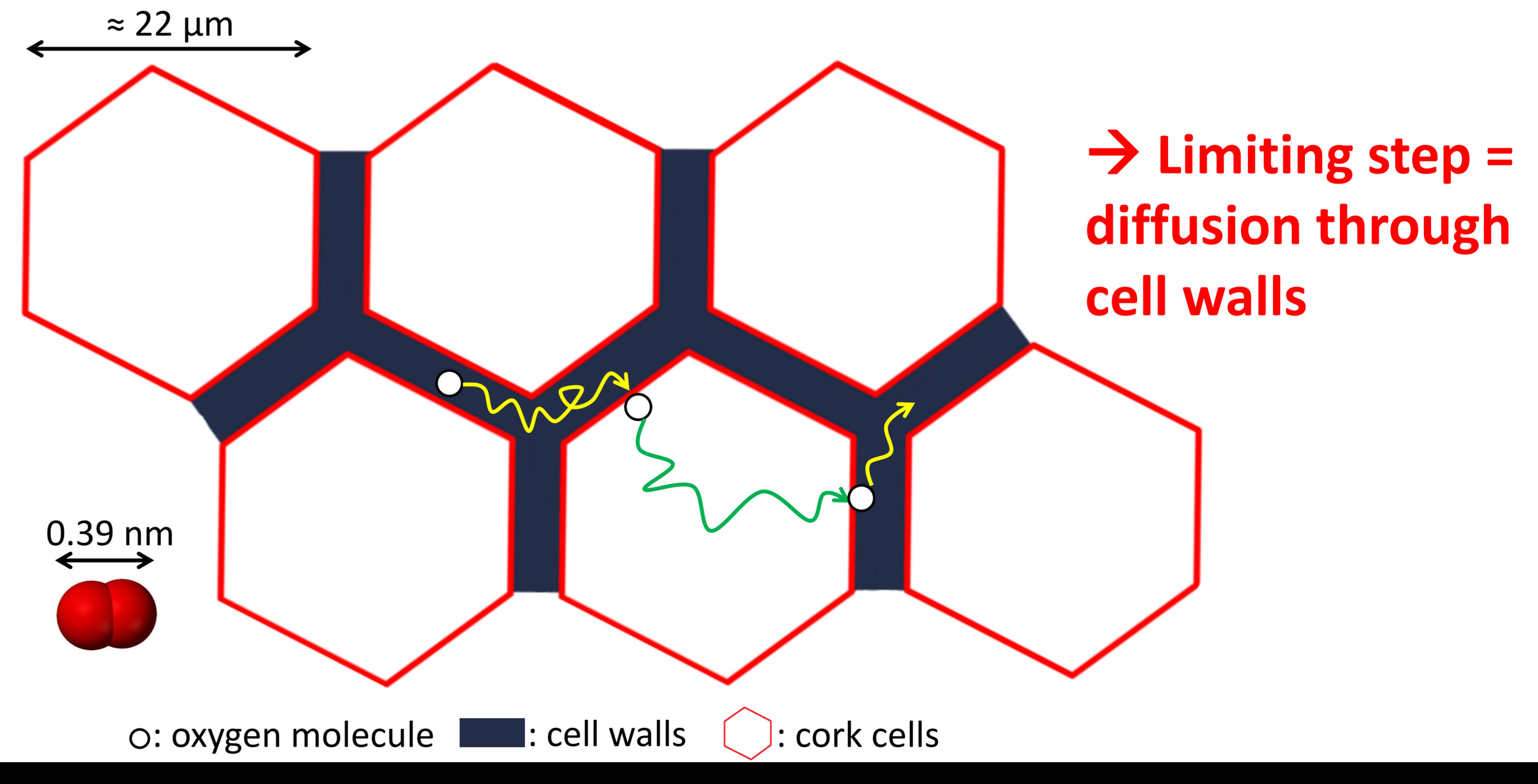


Knudsen $P_K = \frac{d}{3} \sqrt{\frac{8M}{RT}}$

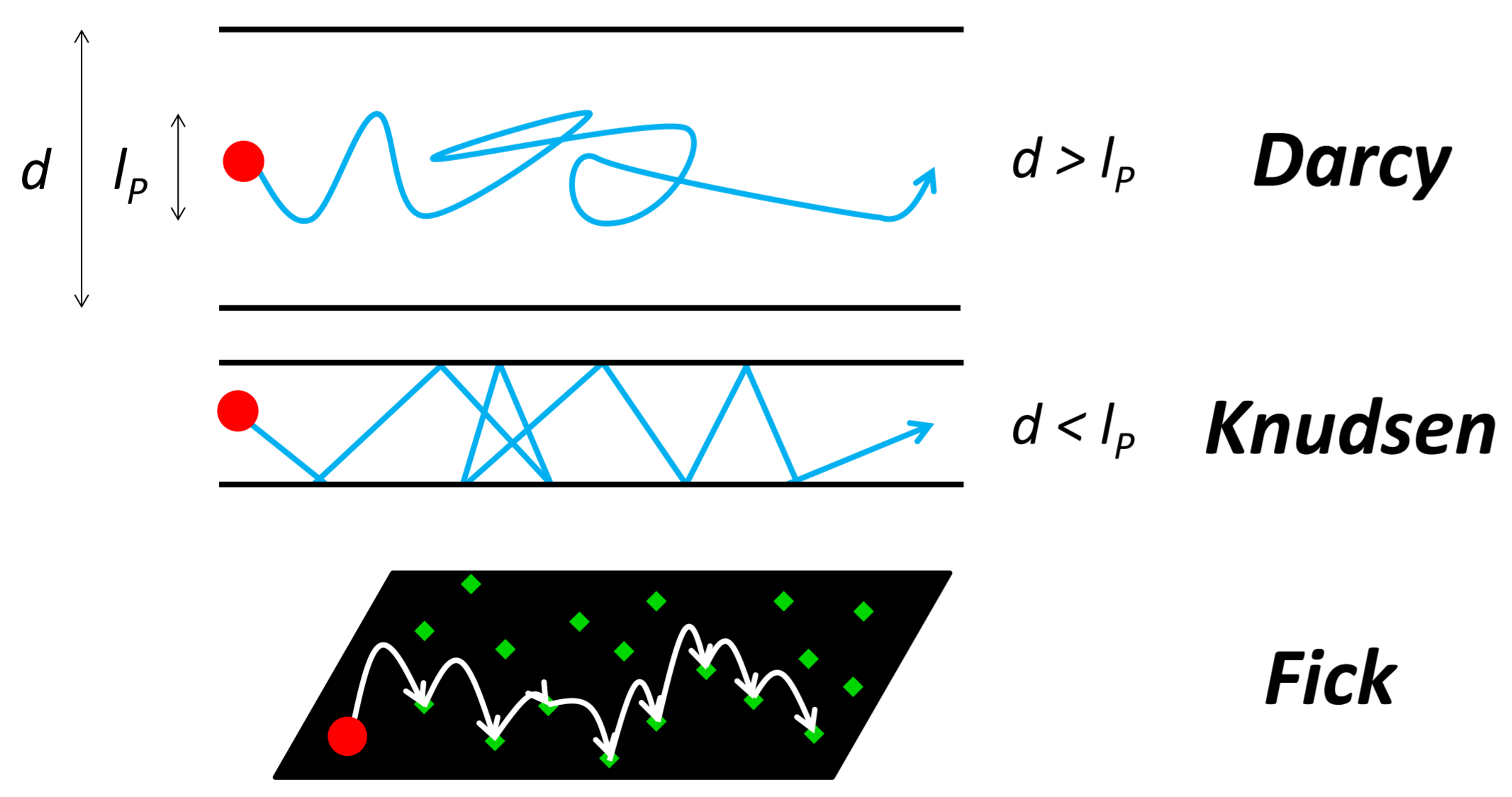
Fick $P_F = \frac{DC_a M}{p}$

→ 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

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[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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