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An imaging method for oxygen distributions, respiration and photosynthesis at a microscopic level of resolution

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Summary:

- Biological samples are far from homogeneous, with complex compartmentation being the norm. Major physiological processes such as respiration do not therefore occur in a uniform manner within most tissues, and it is currently not possible to image its gradients in living plant tissues.
- A compact fluorescence ratiometric-based device is presented here, consisting of an oxygen sensitive foil and a USB (universal serial bus) microscope. The sensor foil is placed on the sample surface and, based on the localized change in fluorescence signal over time, information about the oxygen consumption (respiration) or evolution (photosynthesis) can be obtained.
- Using this imaging technique, it was possible to demonstrate the spatial pattern of oxygen production and consumption at a *c*. 20-µm level of resolution, and their visualization in the rhizosphere, stem and leaf, and within the developing seed. The oxygen mapping highlighted the vascular tissues as the major stem sink for oxygen. In the leaf, the level of spatial resolution was sufficient to visualize the gas exchange in individual stomata.
- We conclude that the novel sensor set-up can visualize gradients in oxygen-consuming and producing processes, thereby facilitating the study of the spatial dynamics of respiration and photosynthesis in heterogeneous plant tissues.

Key-words: fluorescent optical sensors, hypoxia, oxygen imaging, planar sensor, respiration