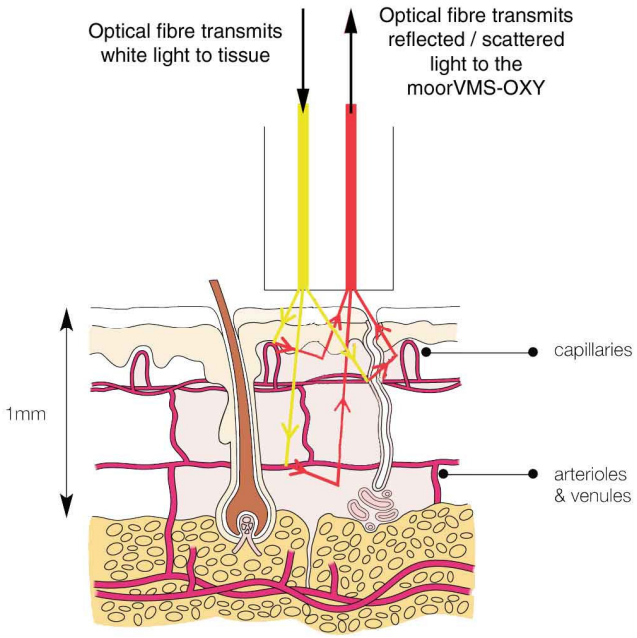
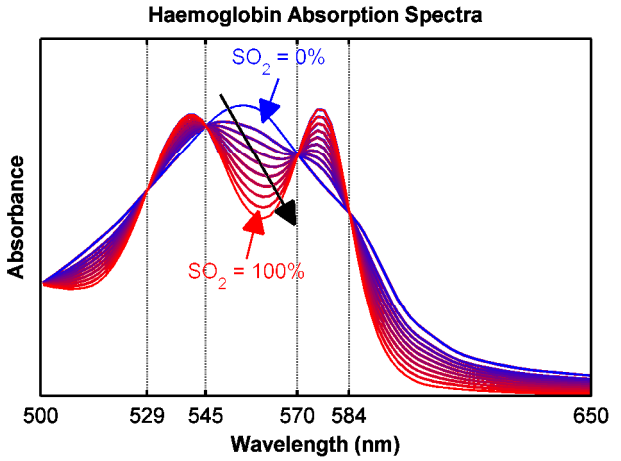
Theory of white light reflectance spectroscopy

The moorVMS-OXY is based on the theory of white light reflectance spectroscopy. Its measurement relies on spectrophotometric principles that relate light absorption to chromophore concentrations. Measurements are taken using probes which are placed in contact with the tissue at the measurement site.

Optical fibres are used to deliver illumination light to the tissue and collect reflectance light to the instrument for processing. For measurements in superficial tissue layers, probes with small delivery collection fibre separations (0.25-2mm) are used, and analysis is performed with spectra in the visible wavelength range between 500-650nm.





$$SO_2 \text{ (percentage)} = \frac{[oxyHb]}{[deoxyHb] + [oxyHb]} \times 100$$

where [oxyHb] and [deoxyHb] are the concentration of oxygenated and deoxygenated haemoglobin respectively.

Explanation:

From the end of the probe, the light spreads out in a diffuse pattern through the tissue. The transport of the photons is governed both by the absorption and scattering properties of the tissue.

A fraction of the light is absorbed when the white light interacts with the red blood cells which contain haemoglobin. As the absorption of light by haemoglobin depends on the wavelength of the light and on the state of its oxygenation, both the total haemoglobin concentration in tissue and the oxygen saturation determine the colour of the tissue, which is the foundation of the spectroscopic measurements. Appropriate algorithms take into account that the spectra are confounded by effects of e.g. the light scattering by all tissue compartments or the absorption of melanin.

The measurement depth is dependent upon the light wavelengths and the fibre spacing in the probe head. The further the fibre separation or the longer the light wavelength, the deeper the possible measurement depth.

Further reading

M. Kohl-Bareis et al, "System for the Measurement of Blood Flow and Oxygenation in Tissue Applied to Neurovascular Coupling in Brain," in Photon Migration and Diffuse-Light Imaging II, K. Licha and R. Cubeddu, eds., Vol. 5859 of Proc. SPIE (Optical Society of America, 2005), paper WA3.

H Liu et al, “Design of an oxygenation monitor and verification on human skin tissue”, European Conferences on Biomedical Optics, 22 - 26 May 2011, Munich,Germany