A study of illuminated manuscripts using optical coherence tomography and non-invasive spectroscopic techniques

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Optical Coherence Tomography (OCT) is a non-contact and non-invasive 3D imaging technique for the examination of subsurface microstructure of materials. OCT has been successfully applied to easel paintings revealing varnish and paint layer stratigraphy, ageing of the varnish, as well as giving the highest resolution and contrast images of underdrawings. In comparison, OCT has not been applied as extensively to illuminated manuscripts. Since sampling is usually not allowed on manuscripts, application of non-invasive imaging and spectroscopic techniques is the only way to examine them. Recently, we used our newly developed ultra-high resolution OCT (UHR OCT) to examine folios in a number of medieval manuscripts in the collection of the Fitzwilliam Museum in Cambridge (UK). The UHR OCT at a central operating wavelength of 810 nm has a resolution of ~1.2 microns in depth (for paint and parchment) allowing the thinnest paint layers to be seen. In this paper, we illustrate how OCT can be used to examine illuminated manuscripts in order to deduce the paint layer thickness and structure, examine the internal microstructure of the parchment and to assist pigment and binding medium identification in combination with visible and near infrared fibre optic reflectance spectroscopy (FORS) and X-ray fluorescence spectroscopy (XRF). XRF identifies elements with atomic number Z>12, while VIS/NIR FORS gives molecular information allowing not only the identification of pigments but also of some binding media. The combination of OCT with FORS and XRF is capable, in some cases, of giving depth-resolved material identification.