Ultra-high resolution Fourier domain optical coherence tomography for resolving thin layers in painted works of art

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Optical Coherence Tomography (OCT) is an imaging technique based on the Michelson interferometer. The sample is illuminated by a source of focused light and the scattered light is collected, processed and an image is displayed. The technique is non-invasive, non-contact and capable of imaging subsurface structures in 3D, making the technique a very useful diagnostic tool for visualization of internal microstructure. Improvement in OCT resolution can significantly increase our knowledge about the structure and composition of the material.

Scientific examination of works of art is essential for conservation, preservation and understanding of material change. In heritage and conservation, OCT technique has found applications in the examination of paintings, jade, ceramics, ancient glass, enamel, parchment, faience and other historical objects.[1,2] It has also been used for dynamic monitoring of the wetting and drying of different varnishes, real time monitoring of varnish removal using solvents and laser ablation of varnish layers as well as tracking of canvas deformation due to environmental changes.[3] Besides the visualization of the stratigraphy of paint and varnish layers, application of OCT to paintings has shown to be the most sensitive technique for revealing preparatory drawings beneath paint layers owing to its high dynamic range and depth selection capabilities.

While current OCTs have shown potential in this field, the best resolution commercial OCT at any wavelength is rarely better than 5μm in air. Currently depth resolution of OCTs used in these applications cannot compete with microscopic examination of sampled paint cross-sections. Conventional microscopic examination of paint cross-sections has resolution approaching 1μm. Since the depth resolution of OCT is proportional to the source bandwidth, ultra wide bandwidth light sources allow greater depth resolution to be achieved. It is known that some varnish and paint layers can be as thin as a few microns. By using a supercontinuum source (NKT SuperK Versa), we have developed a spectral domain OCT at 815nm for high depth resolution imaging of varnish and paint layers. The theoretical depth resolution of 2.2μm in air (or ~1.5μm in varnish) is achieved and it is shown to be able to resolve thin varnish layers.

REFERENCES

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