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Artworks characterization at THz frequencies: preliminary results via the Fiber-Coupled Terahertz Time Domain System

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In the research field of art and archaeology, scientific observation and analysis are hugely demanded to gather as more information as possible on the materials and techniques used to create artworks as well as in previous restoration actions. In this frame, diagnostic tools exploiting electromagnetic waves deserve massive interest tanks to their ability to provide non-invasive and possibly contactless characterization of the investigated objects.
Among the electromagnetic diagnostic technologies, those working at frequencies belonging to the 0.1–10 THz range are currently deserving an increased attention since THz waves are capable of penetrating into optically opaque materials (up to the preparation layers), without direct contact and by involving sufficiently low energy to be considered as perfectly non-invasive in practice [1,2]. Moreover, being THz non-ionizing radiations, a moderate exposure to them implies minor long term risks to the molecular stability of the historical artifact and humans. Finally, recent developments of THz technology have allowed the commercialization of compact, flexible and portable systems. One of them is the Fiber-Coupled Terahertz Time Domain System (FICO) developed by Z-Omega, acquired by the Institute of Electromagnetic Sensing of the Environment (IREA) in 2013. This system works in the range from 60GHz to 3THz with a waveform acquisition speed up to 500Hz, it is equipped with fiber optic coupled transmitting and receiving probes and, few months ago, has been potentiated by means of an automatic positioning system enabling to scan a 150mm x 150mm area.
In the frame of the IREA research activities regarding cultural heritage, the FICO system is currently adopted to perform both spectroscopy and imaging, which are the two kind of analysis wherein THz technology can be profitably explored [3]. In particular, THz spectroscopy is used to distinguish different artists materials by exploiting their peculiar fingerprint in the absorption spectra, while imaging includes THz tomography and it is considered to obtain non-invasive cross-section images of the artwork under test.
Preliminary experiments regarding laboratory designed objects and not precious artworks have been carried out at the IREA laboratory mainly to trace measurements protocols and deeply investigate the diagnostic capabilities of the FICO system. The obtained results will be illustrated and discussed at the conference.

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