

STSM REPORT

STSM Application number: ECOST-STSM-BM1205-100316-072255

STSM Grantee: Dr Faustino Wahaiá

STSM title: Terahertz and infrared imaging and spectroscopic techniques for early cancer detection and nanomaterials characterization

Home Institution: INEB/ Biointerfaces and Nanotechnology, Researcher, i3S - Instituto de Investigação e Inovação em Saúde, Universidade do Porto (UP), Porto, Portugal (PT)

Host Institution: Dr Irmantas Kašalynas, State Research Institute Center for Physical Sciences and Technology (CPST), Vilnius, Lithuania (LT)

STSM period: 5 – 30 April, 2016

STSM purpose: Research

Description of the work carried out and the main results obtained during the STSM:

On the basis of the sensitivity of THz waves to tissue hydration from normal to abnormal bio-tissue fact that allows distinguishability of the two states, we, therefore, show that terahertz time-domain spectroscopy (THz-TDS) can be used to characterize biological tissue. Healthy and adenocarcinoma-affected gastric tissue-samples have been measured using transmission THz-TDS. The complex optical constants were obtained in the THz frequency region. The THz absorption constants are shown to vary linearly with the degree of pathologic staging. These results demonstrate that THz-TDS can ease the qualitative analysis of samples, making possible the discrimination between normal and abnormal tissue. To do that we analyzed absorption coefficients (α) and refractive indices (n) spectra of both normal and carcinoma-affected tissue.

A set of 20 anonymous of normal and carcinoma-affected human gastric tissues were obtained from the Department of Pathologic Anatomy of Centro Hospitalar São João of Porto, Portugal. The work with the biological samples was under Authorization of Ethics Commission, CES 211-13 – Centro Hospitalar S. João – EPE, Porto, Portugal.

Histological samples with constant thickness of 2 mm were taken from partial distal and total gastrectomy. The histologic analysis classified samples in adenocarcinoma type pT3 and pT4 tissues which have been mounted into paraffin blocks as shown in digital photo in Fig. 3. The first tissue (marked pT3) correspond to gastric adenocarcinoma, tumor penetrating subserosal connective tissue without invasion of visceral peritoneum or adjacent structures^{23,24}. While in the second type tissue (marked pT4), tumor which invades serosa (visceral peritoneum)²³. The tissue samples preparation and acquisition procedures were comprised in three steps: 1) Specimens preparation and fixation; 2) selection of tissue from the specimens; and, 3) processing the tissue of the samples. The tissue samples were prepared according to the standard protocols approved in hospital. The samples were placed in a solution of formalin buffered at 10% (%V/V) during 24 hours. Then the samples were submitted to a standardized fixation in formalin buffered at 10%, dehydrated with crescent concentrations of ethanol (75% - 90% - 100%), clarification with xylene. All the samples were measured under the same conditions at room environment.

The normal and carcinoma-affected zones in each sample have been previously identified by histological examination. Measurements have been performed in randomly chosen points on the samples, and have been at room temperature. Before starting the measurements, the sample tissues have been sandwiched between two 50 × 30mm HDPE plates of 1mm of thickness separated with a spacer of 1.75 mm thickness.

The two plates were slightly pressed onto the tissue in order to get rid of air gaps between sample surface and HDPE plate.

For the measurements, a fiber-coupled THz Spectrometer “T-Fiber - EKSPLA/Teravil” was used. It has an integrated femtosecond fiber laser with two fiber output ports. The femtosecond laser with fast delay line and signal registration electronics are integrated in a single compact housing with footprint only 40×40 cm. The fast delay line allows real time data acquisition with 10 spectra/s speed and, 110 ps time window. Spectral resolution <10GHz. THz emitter and detector are fiber coupled. The laser is a “LightWire FF50 (Ekspla)”, with 1064 nm, central wavelength, a pulse duration of <160fs, 60 mW output power and, a pulse repetition rate of 40 MHz.

Description of the main results obtained:

Research activity with Journal publications that should also bring the following outcomes in terms of social impact,

Increase in the endoscopists’ ability to locate dysplastic or cancerous tissue by the use of non-invasive, non-painful, non-time consuming and non-ionizing diagnostic screening technique;
Provide to the physicians the ability to target dysplastic or cancerous tissue visually difficult to detect or undetectable using current endoscopic systems;

Provide a powerful technique, capable of accurate identification of margins of the diseased areas prior to performing any removal surgery;

Improve the sensitivity to identify dysplasia enabling physicians for earlier actions in treatment to stop the progression of premalignant disease;

Implement an earlier treatment, which could result in better health care and, therefore, better patients’ outcomes.

Mutual benefits for the Home and Host institutions:

Scientific publications in peer reviewed international journals and Promising results in prol of for a better health care.

Future collaboration with the Host institution (if applicable):

The Collaboration began from 2009, throughout the PhD Thesis work. The present research collaboration, it is to last up to 2016, with renewal of periods at expected new further projects.

Foreseen journal publications or conference presentations expected to result from the STSM (if applicable):

From the present STSM we are submitting one paper, “Gastric Cancer Screening using THz Spectroscopy” (the first one of 3 papers to be submitted for publication), and, therefore, two more papers are in view, “Imaging of gastric tissues and gold nanoparticle-enabled THz imaging”.

Connect also this to the results

| STSM application number | Home institution & country | Host institution & country | BM1205 WG3 | Objective of the collaboration | Results of the collaboration |
|---------------------------------|--|--|--|---------------------------------------|--|
| ECOST-STSM-BM1205-100316-072255 | INEB/ Biointerfaces and Nanotechnology, Researcher i3S - Instituto de Investigação e Inovação em Saúde Universidade do Porto (UP), Portugal | State Research Institute Center for Physical Sciences and Technology (CPST), Vilnius, Lithuania | WG 3: Tissue characterisation at terahertz frequencies using THz imaging and THz TDS systems. | Applied Research | Very good and scientifically promising |

Vilnius, 27 May 2016

Dr. Irmantas Kašalynas
CPST

Porto, 27 May 2016

Dr Faustino Wahaia
UP

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| ECOST-STSM-BM1205-100316-072255 | INEB/ Biointerfaces and Nanotechnology, Researcher i3S - Instituto de Investigação e Inovação em Saúde Universidade do Porto (UP), Portugal | State Research Institute Center for Physical Sciences and Technology (CPST), Vilnius, Lithuania | WG 3: Tissue characterisation at terahertz frequencies using THz imaging and THz TDS systems. | Applied Research There was a progress in fiber-coupled THz-TDS spectrometer setup, and tissue optical frequency-dependent optical parameters extraction methods. Improved HDPE sample holders, allowing better spectrometer alignment and speedy measurements | Very good and scientifically promising |

Hereby I confirm that Dr Faustino Wahaia visited our Research Group at State Research Institute for Physical Sciences and Technology, Vilnius, from 5 to 30 April 2016. The measurement session yielded very good results. We, for this STSM expect to publish two or three papers as a result of the Dr. Faustino's work visit.

Vilnius, 27 May 2016



Dr. Irmantas Kašalynas
CPST

Porto, 27 May 2016

Faustino Wahaia

Dr Faustino Wahaia
UP