THz Spectroscopy and Imaging for Breast Cancer Detection in the 300-500 GHz range

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Spectro-terahertz (THz) imaging is a burgeoning field since the high sensitivity of submillimeter waves to tissue water concentration has been brought to light (Woodward *et al*, 2002). In addition, it has been demonstrated previously, the significant water concentration difference between normal and abnormal tissues (Ross and Gordon 1982). Hence, we draw-up the report on our technological progresses led with both Transmission and Reflection mode to discriminate breast malignant tissues from healthy ones. In this work, we focus on the optical properties of different freshly excised human tissues on a single point measurement that are extracted through a dedicated home-made algorithm, following fan et al,2016 procedure. We can access to a dielectric property map of the biological sample (Fig. 1). It may provide, from the knowledge of this optical property picture, precious information to diagnose and to identify the cancerous regions during the analysis. Then, we propose a rigorous procedure to ensure the repeatability and the accuracy of our techniques. Next, we will show some images obtained in this frequency range (Fig. 2 H. Balacey et al 2016). This crucial step will provide access to both chemical and physical interactions between THz radiations and human biospecimens for each sample preparation step and prepare interpretation of near field analysis at 550 GHz chosen frequency for its contrast perspectives of tissues (J. Grzyb et al 2017).

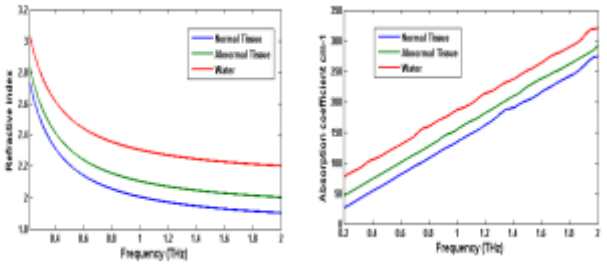

Fig 1: THz properties for water and breast tissue . Refractive index and absorption coefficient of bad and normal tissue in the THz range

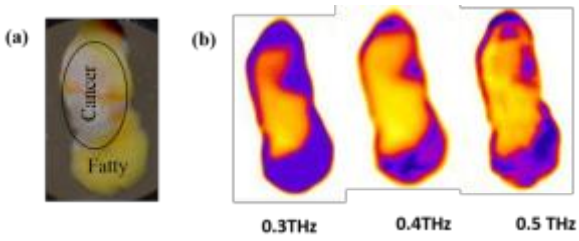

Fig.2: a) *visible image of fresh breast tissue. THz images of raw data-reflection for fresh tissue as: frequency domain image at 0.3, 0.4, & 0.5 THz respectively*

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References

H. Balacey, B. Recur, J-B Perraud, J. Bou Sleiman, J-P. Guillet, P. Mounaix, Advanced Processing Sequence for 3-D THz Imaging IEEE Trans on Terahertz Science and Technology **6**, 2 191, 2016.

Fan, Shuting Parrott, Edward P. J. Ung, Benjamin S. Y. Pickwell-MacPherson, Emma, Calibration method to improve the accuracy of THz imaging and spectroscopy in reflection geometry, **4,** 3 June 2016, Photon. Res, 2016.

J. Grzyb, B. Heinemann, and U. R. Pfeiffer, Janusz Grzyb, Bernd Heinemann, Ullrich R. Pfeiffer, "Solid-state terahertz super-resolution imaging device in 130nm SiGe BiCMOS technology," accepted for Trans. MTT, 2017.

Ross K F and Gordon E R, 1982, Water in malignant tissue, measured by cell refractometry and nuclear magnetic resonance. *J. Microsc.* **128** 7-21.

Wooward R M, Cole B E, Wallace V P, Pye R J, Amone D D, Linfield E and Pepper M, Terahertz pulse imaging in reflection geometry of human skin cancer and skin tissue. *Phys. Med. Biol.* **47** 3853-63, 2002,