FTIR spectroscopy for diseases diagnosis

Denise Maria Zezell

Instituto de Pesquisas Energéticas e Nucleares (IPEN - CNEN/SP)

Mid-infrared spectroscopy is a technique by which the chemical structure of an analyzed material can be identified; it also allows the semi-quantitative analysis of the components of the material. It has been already shown that Fourier transform infrared spectroscopy (FTIR) can be used to evaluate the effects of high-intensity laser irradiation on dentin and enamel tissues,as well as for the study of bone properties and several pathologies, such as lung, thyroid and skin cancer.

The structural and biochemical changes associated with the development of enamel caries and also with the interaction of laser irradiation with the enamel, suggest that vibrational spectroscopy are promising techniques to differentiate sound and carious enamel, as well as detect changes due to laser irradiation. Considering that there is no agreement in the literature on the chemical changes promoted by the irradiation of Nd:YAG and Er,Cr:YSGG for preventive purposes on enamel, our studies aimed to determine these changes by FTRaman and FTIR spectroscopy and to investigate the influence of laser irradiation before or after the application of topical fluoride on the development of caries in vitro.

Nonmelanoma skin cancers represent 95% of cutaneous neoplasms. Among them, squamous cell carcinoma (SCC) is the more aggressive form and shows a pattern of possible metastatic profile. In this work, we used Fourier transform infrared spectroscopy (FTIR) spectroscopy to assess the biochemical changes in normal skin caused by squamous cell carcinoma induced by multi-stage chemical carcinogenesis in mice. Changes in the absorption intensities and shifts were observed in the vibrational modes associated to proteins, indicating changes in secondary conformation in the neoplastic tissue. Hierarchical cluster analysis was performed to evaluate the potential of the technique to differentiate the spectra of neoplastic and normal skin tissue, so that the accuracy obtained
for this classification was 92%.

We develop a methodology to interpret hyperspectral imaging data and protein conformational changes observed in nomal thyroid tissue. Raw image datasets
were imported into software written in-house in the MATLAB environment and processed to yield pseudo-color images of the tissue sections. All spectra were vector normalized, noise-filtered, and corrected for water-vapour contributions and scattering effects before being subjected to Hierarchical Cluster Analysis (HCA) and correlated with histological structures obtained from images of H&E-stained parallel tissue sections. We successfully identified a protein structural heterogeneity that can be correlated with the spatially resolved amount of iodine in the thyroglobulin structure of colloids and follicular cells.

The chemical carcinogens from tobacco are related to over 90% of lung cancers around the world. The risk of death of this kind of cancer is high because the diagnosis usually is made only in advanced stages. Therefore, to develop new diagnostic methods for detecting the lung cancer in earlier is very important
stages. The second derivate of spectra indicates that there are displacement in 1646 cm-1 (amine I) and 1255 cm-1 (DNA), allowing the possibility to differentiate the e10 lung normal cells from e10 lung cells transformed by tobacco substances (NKK) with accuracy of 89,9%.

Acknowledgements: This work was supported by FAPESP/CEPID proc. 05/51689-2, CAPES/PROCAD proc. 88881.068505/2014-01; CNPq INCT proc. 573.916/2008-0 and CNPq proc. PQ 312397/2013-5.