International Conference on Advanced Optical Technologies
University of Erlangen-Nürnberg, March 13th – 15th 2019

Laser-Induced Breakdown Spectroscopy (LIBS): An immerging modality for revealing elemental distribution in tissues

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Abstract

A Laser-Induced Breakdown Spectroscopy (LIBS) based 2-dimensional elemental mapping of tissue slices is demonstrated. The technique allows obtaining multi-elemental information from each point making it attractive for micro characterization of patho-physiological processes of diseases such as cancer.

Introduction

Monitoring diseases such as cancer at their microenvironment level is an immerging research field which aims at understanding the progress the disease or the outcomes of therapy. These have attracted imaging modalities capable of monitoring the tumor microenvironment. LIBS as analytical technique capable of monitoring elements in microns scale lies within the premise of the interests of cancer studies in particular and tissue characterization in general [1]. In this work, preliminary results showing the distribution of elements in tumor tissue obtained from mice cancer models is demonstrated.

Experimental setup

The LIBS setup consists of an Nd:YAG laser (wavelength of 532 nm, pulse duration of 5 ns and pulse energy ~ 80 mJ). After focusing the laser, the LIBS spectra from the plasma were collected using a fiber connected to a spectrometer. The sample is attached to a stage allowing for scanning of the different part of the sample. A schematic of the setup used is shown in Fig. 1.

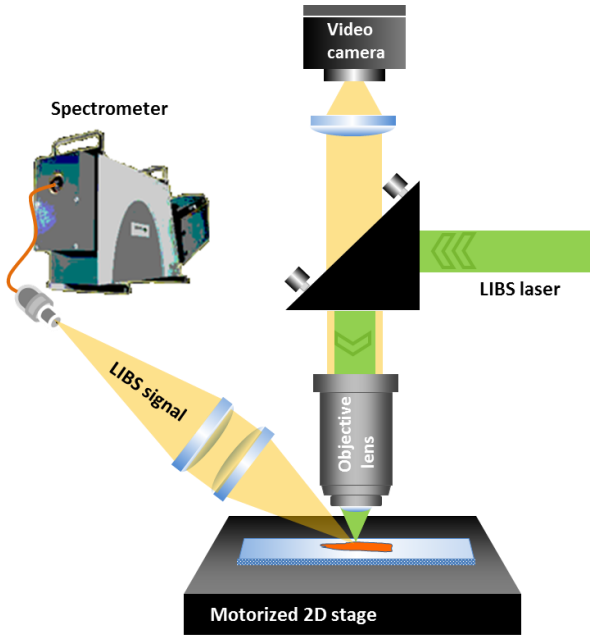

Fig. 1: Schematic of the LIBS scanning system

Results and discussion

The LIBS spectra revealed the presence of both the major and trace elements in the tissue. The major elements O, N, H and C were measured. In addition, trace elements Na, Ca, K, Fe and Cu were also measured. Fig. 2 shows an image of a tissue and its corresponding image based on the emission intensity of the major elements (O and C) and trace elements (Cu and Fe) in arbitrary units. In LIBS the intensity of emission line of an element is directly related to its concentration.

The preliminary results indicate that there is no marked difference in the distribution of the major elements and most of the trace elements between the tumor and its surrounding for this particular sample. However, the concentration of Cu was found to be higher in the tumor region compared to its surrounding. This is in agreement with similar studies on human cancer where copper has shown higher concentration in the tumor part than its surrounding healthy tissue [2].

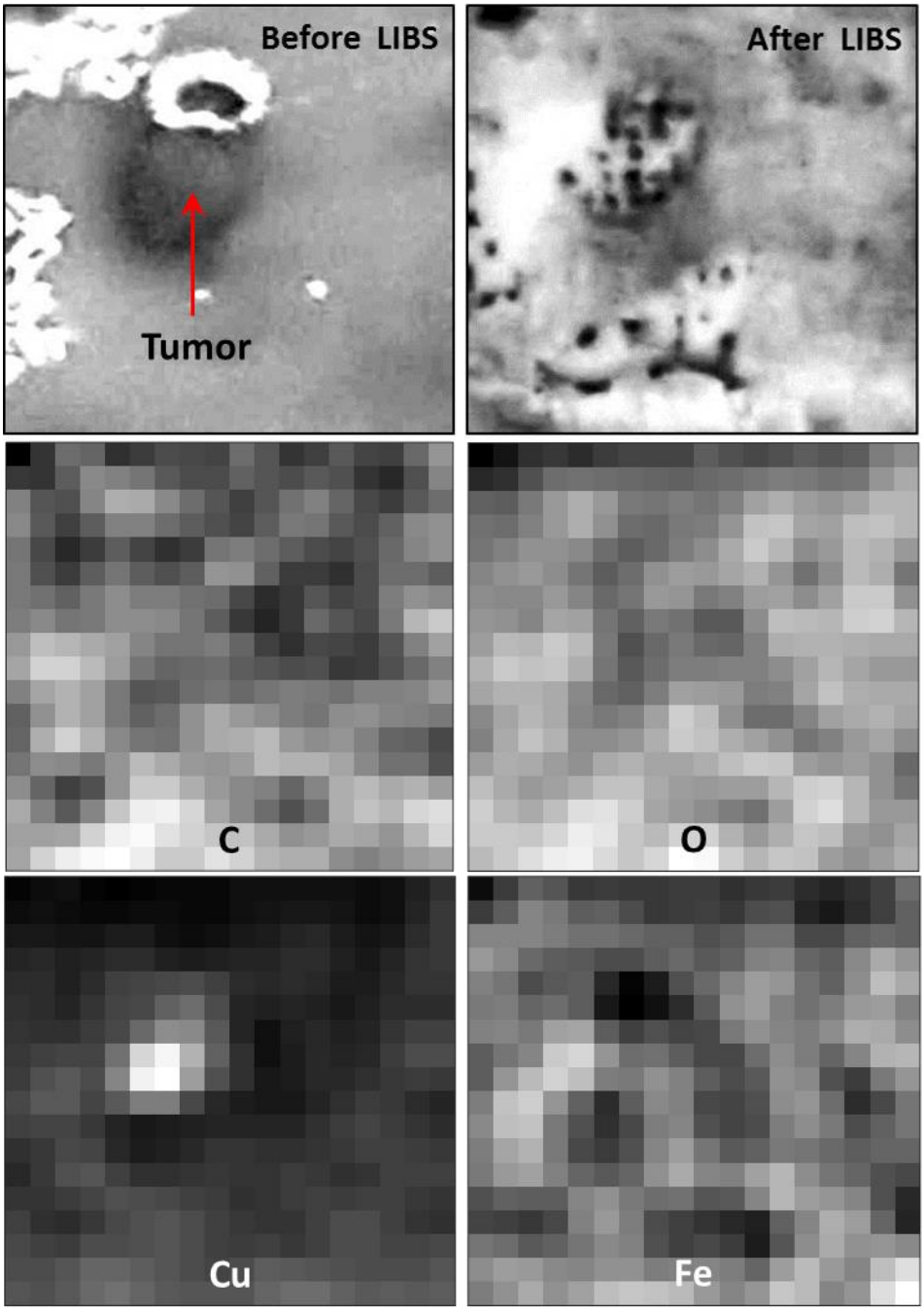

Fig. 2: LIBS based image based on major and trace elements.

Conclusion

The preliminary results show that LIBS as an analytical technique has the potential to reveal the distribution of elements, in terms of concentration, in biological samples.

References

[1] Sancey, L., et al., *Laser spectrometry for multi-elemental imaging of biological tissues.* Scientific reports, 2014. **4**.

[2] Farquharson, M. and A. Al-Ebraheem, *Micro-elemental mapping of trace elements in breast tissue.* 2008, 2009.