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DETECTING INDIUM IN ELECTRIC WASTE USING LASER INDUCED BREAKDOWN SPECTROSCOPY

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Abstract. In this paper preliminary results regarding testing of laser induced breakdown spectroscopy technique for detecting indium in electric waste are presented.

1. INTRODUCTION

Our system for time-resolved laser induced fluorescence (TR-LIF) measurement is described in Terzic et al. (2008) and Rabasovic et al. (2009a,b). First published results could be found in Rabasovic et al. (2008). Nd:YaG laser used in our TR-LIF experiments is powerful enough (365 mJ at 1064 nm, variable OPO output >5mJ), so that the system also could be used for laser induced breakdown spectroscopy (LIBS). In this paper, preliminary results regarding testing of LIBS technique for detecting indium in electric waste are presented.

Indium is a soft, gray metallic element which belongs to the elements of group III of the Periodic Table. It was found and spectroscopically identified as a minor component in zinc ores. Because of its low melting point, 429.75 K, it is technologically attractive, especially in the semiconductor industry and optoelectronics. Optically transparent electrodes used in liquid crystal displays (LCD) are made of indium tin oxide. However, the uses of indium are rapidly increasing and there are many other electronic devices which contain indium. It is relatively rare and ranks 61st in crustal abundance. It is about three times as abundant as silver. Our results regarding electronic spectroscopy of Indium could be found in Rabasovic et al. (2008, 2009a).

2. THE EXPERIMENTAL SET-UP

The system for LIBS measurements is shown schematically in Fig. 1. This system is based on the tunable OPO system (320-475 nm) based on Nd:YAG laser to excite samples and on the detection part with high spatial and temporal resolution Terzic et al. (2008). Compared to the TR-LIF system presented in Terzic et al.

(2008) and Rabasovic et al. (2009a,b), it is easily noted that focusing lens is added. To be on the safe side regarding Hamamatsu Streak Camera, preliminary experiments were made using OPO output (5 mJ at 400 nm) and Ocean Optics spectrograph. It should be noted that using of streakscope enables time resolved diagnostics.

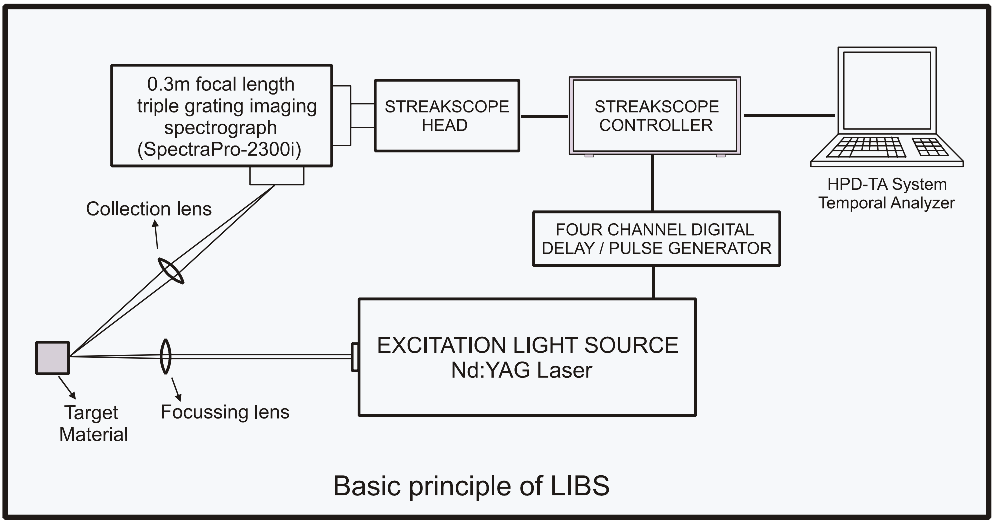

Figure 1: Our TR-LIF system modified for LIBS experiments.

Energy of OPO output is much smaller than energy of our Nd:YAG, which is as high as 365 mJ at 1064 nm, so we could use even more power for future LIBS experiments.

3. PRELIMINARY RESULTS

LIBS spectra for almost pure indium sample (used in our ESMA experiments) and basis plate of LCD are presented in Figs. 2 and 3. Indium spectral lines seen at the Fig. 2 are in good agreement with the data provided by NIST Atomic Spectra Database, Ralchenko et al. (2008).

Samples were excited by OPO output (350 nm, 5 mJ). However, the OPO, the second harmonic (532 nm) and the fourth harmonic (266 nm) are not visible, or more or less not visible in Figs. 2 and 3, because they were background subtracted.

Indium spectral lines are easily seen in Fig. 3, however, lines of other elements could be noticed, as well. Sodium is of no surprise, because LCD basis plate is made of glass. However, aluminium is somehow surprising, because laser was focused on Indium Tin oxide electrode, not on other parts of handheld calculator.

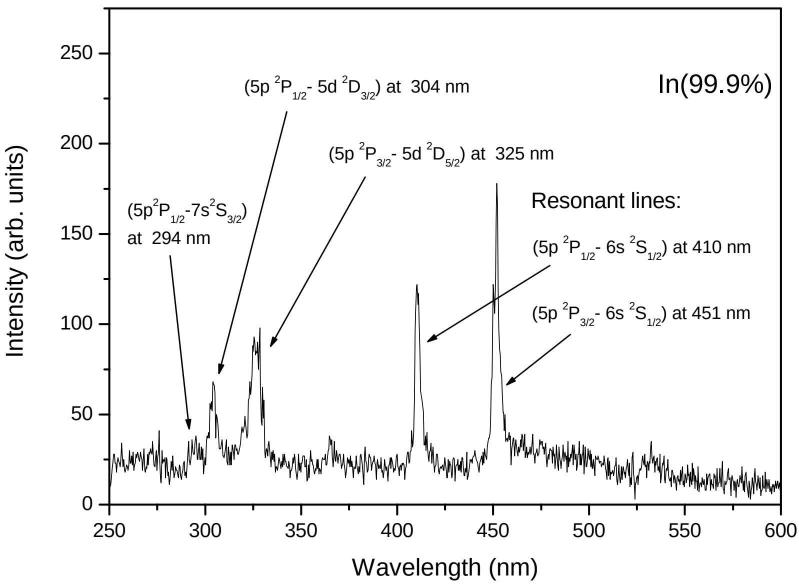

Figure 2: LIBS signal obtained from pure indium sample. Laser harmonics and OPO were background subtracted.

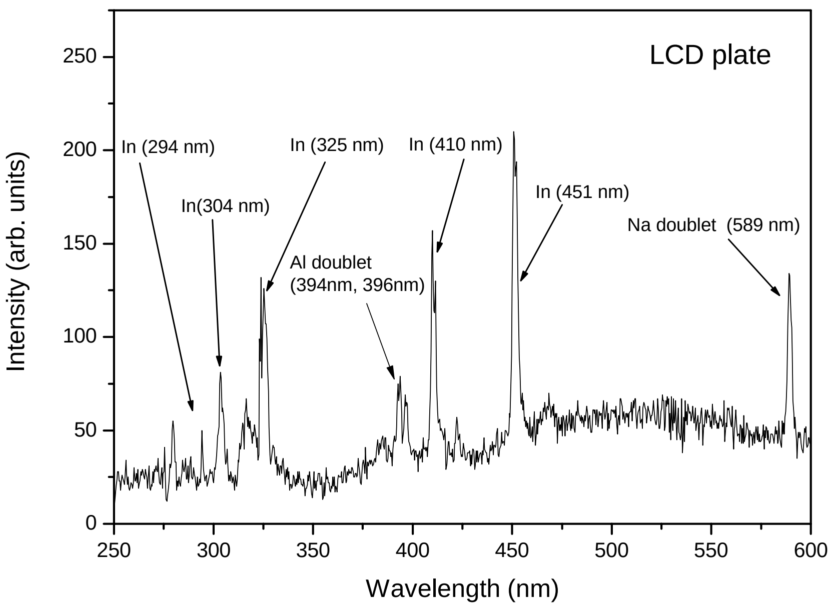

Figure 3: LIBS signal obtained from basis plate of LCD. Laser harmonics and OPO were background subtracted.

Acknowledgements

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