



# SOCIETY OF PHYSICS STUDENTS

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## SPS Chapter Research Award Proposal

Project Proposal Title	<b>Identification of Glasses Using Laser Induced Breakdown Spectroscopy (LIBS) Technology</b>
Name of School	Tuskegee University
SPS Chapter Number	<b>7446</b>
Total Amount Requested	\$1967

### Abstract

The purpose of our proposal to use LIBS is to study the elements present in glass samples. In order to have a good quality of optical glasses (for example rare earth doped glasses) there has to be a very precise concentration of dopant present in the glass. The LIBS technique has real time monitoring capability of elements and it will give a good solution for quality control in the process of manufacturing. It is proposed here to use LIBS technique to monitor rare earth ions in glass samples.

### Proposal Statement

#### Overview of Proposed Project

LIBS is an analysis method that uses an high energy pulsed laser (Nd: YAG laser) to create plasma plume of a solid, liquid, or gaseous sample and record the emission spectrum of cooling plasma to tell the atoms present in the sample. This analytical technique can be used to study sample in any physical form with very minimum or no damage to the sample. There are plenty of applications of the LIBS technique [1-8] for example it can be used to study paints used in famous paintings, meteorites, or the amount of pollution in bodies of water.

. The goals of the project would be following:

1. To identify the elements present in the glass samples.
2. To establish the best experimental conditions to identify the lowest concentration of rare earth elements present in the glass sample and to be able to find the Limit of detection (LOD).

#### Background for Proposed Project

The Nd: YAG laser light passes through a double convex lens to focus its energy onto the sample. The laser pulses carry energies typically in the range of 10 to 100 mJ depending on the sample. The sample particles at the focal spot of the laser become ionized, creating a small plasma plume. The atoms in the resulting ionized gas get excited and then they relax after a few microseconds, causing characteristic spectral emissions. The emitted light travels through a series of collecting lenses, which focuses the light and delivers it to a fiber optic system, which then carries the light to a spectrometer, as seen in the following picture. Laser Induced Breakdown

Spectroscopy does not require any special preparation for the sample, allowing its work to be done from a distance.

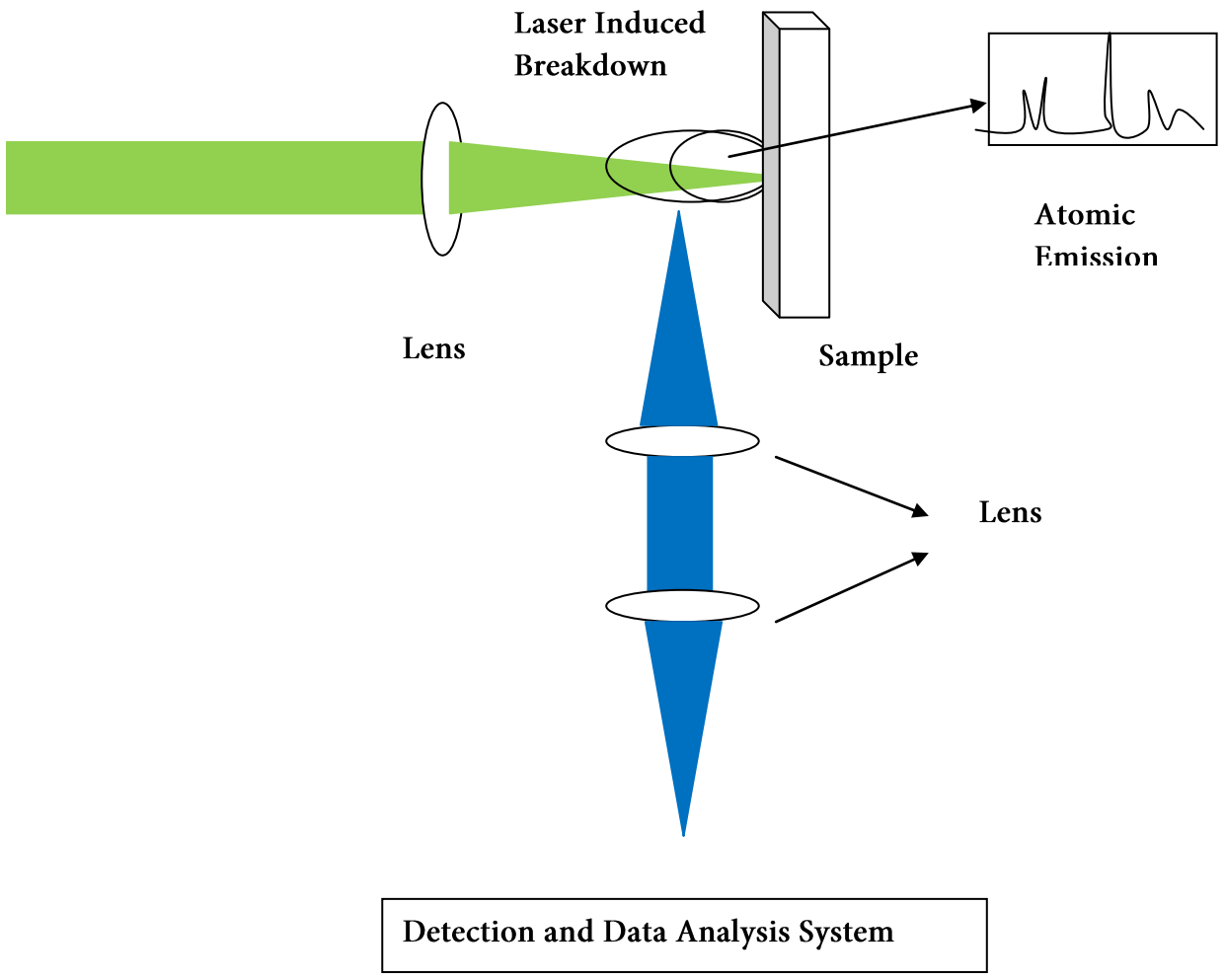


Figure 1 Illustrating LIBS

The light intensity carried to the spectrometer is plotted with respect to its wavelength. The spectrometer shows the peaks of the light emission. Those peaks can tell what elements are in the sample. These results are given relatively quickly in real time. A typical LIBS spectrum of a steel sample is given below,

### LIBS Spectra of an steel plate

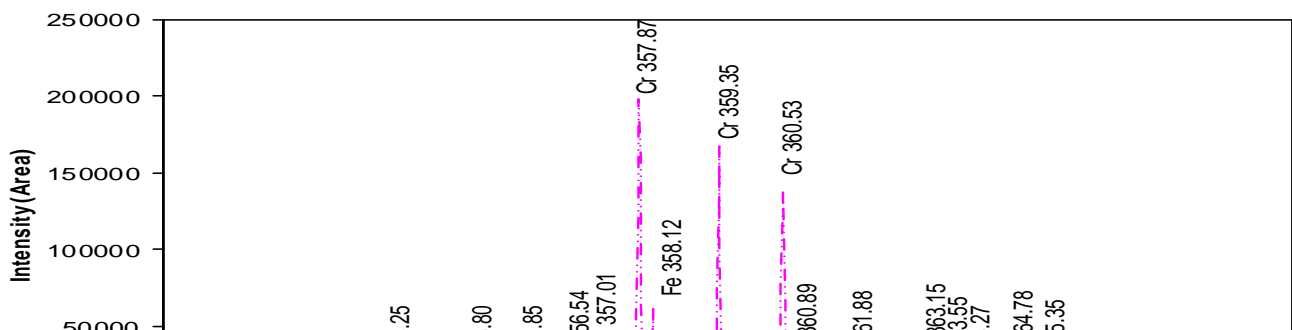


Figure 2 Wavelength Measurements Found by Spectrometer

## Proposed Plan

### Development of Rare Earth Ions Doped Glasses in the LAB:

Several rare earth doped glasses will be developed in the Lab. We have high temperature furnace and all the glass making facility is present in our lab.

### Identification of Elements Present in the Glass Samples using LIBS technique:

After making the rare earth doped glasses the samples will be tested with the LIBS technique.

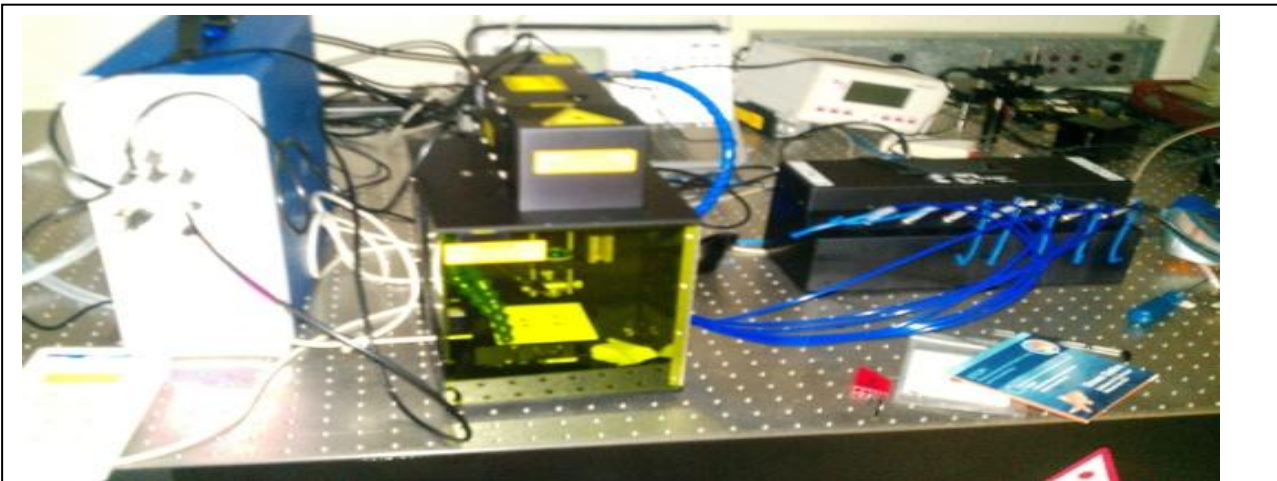


Figure 4: LIBS Setup: Ocean Optics LIBS 2500 plus spectrometer along with LIBS Sample Chamber and laser.

Figure 3 Set up for LIBS in our LAB

### Expected Results

The expected results are as follows;

1. Be able to find the experimental conditions to record the LIBS spectrum of the glass samples. These experimental conditions would be laser to sample distance, laser power etc. to get maximum signal strength.
2. Be able to generate a data bank to perform statistical analysis of glass samples.

### Description of Proposed Research - Methods, Design, and Procedures

We are proposing to perform the LIBS spectroscopy of glass sample by placing under the focused laser for the LIBS experiment. The whole process is shown in figure 3.

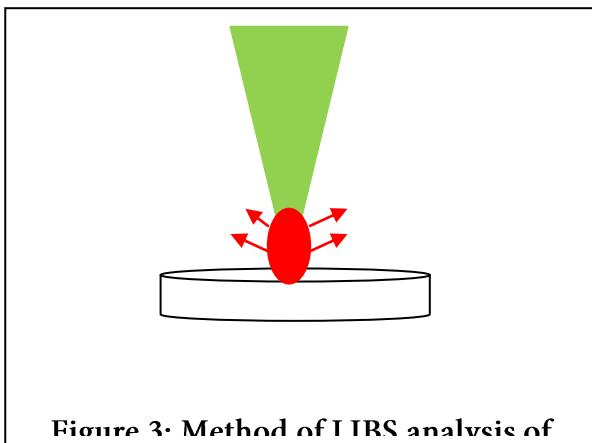


Figure 3. Method of LIBS analysis of

### Plan for Carrying Out Proposed Project

#### Proposed Experimental Plan:

1. Make rare earth doped glasses.
2. To find the effect of laser to sample distance on the LIBS spectrum of the glass sample.
3. To find the effect of intensity of the laser beam on the LIBS signal of the glass samples.
4. To find the effect of delay between the laser pulse and detection device.
5. To collect glass samples from the various commercial brands and record the LIBS signal.
6. To analyze the recorded LIBS signal.

Faculty members are using LIBS equipment for the research purposes. Taking guidance and working in collaboration with faculty members is planned. The outcomes of our experimental findings will also be presented in local SPS chapter meetings. The proposed work would be done under the faculty advisors Dr. Akshaya Kumar and Dr. Prakash C. Sharma in physics Department Tuskegee University. Department of physics has Ocean Optics LIBS spectrometer along with pulsed YAG laser in the Laser and Optics Laboratory.

### Project Timeline

Time	Jan 1, 2015 to Feb.	Feb 1, 2015 to May 31,	June 1, 2015- October	November 1, 2015 to
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	28,2016	2016	31, 2016	December 31, 2016
Task	Making glass Samples. Learning operating procedure of lasers and spectrometer. Reading literature	Making Glass samples Writing interim report.	Recording LIBS spectrum Analyzing collected data. Identifying the need of changing experimental condition and recording the additional data if required.	Writing final report Writing paper. Preparing presentation for a conference.

## Budget Justification

LSB01-C - Ø1" N-BK7 Plano-Convex Lens Kit, ARC: 1050-1620 nm, 14 pc (\$687), MTS50-Z8 - 50 mm (1.97") Motorized Translation Stage, 8-32 and 4-40 Taps (\$1040), Chemicals Tellurium dioxide (\$118), Erbium oxide (\$63.60), Lithium carbonate (\$58.40). Total \$1967.

## Bibliography

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- [3] F.Y.Yueh, J.P.Singh and H.Zhang “Elemental Analysis with Laser Induced Breakdown Spectroscopy” In *Encyclopedia of Analytical Chemistry*, John Wiley and Sons. Ltd, Chishester, U.K., 2000.
- [4] D.A. Rasak, B.C.Castle, B.W.Smith, and J.D.Winefordner, *Critical Reviews in Analytical Chemistry* 27(4):257-290(1997)
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- [6] Application of laser-induced breakdown spectroscopy for total carbon quantification in soil samples. Ayyalasomayajula KK, Yu-Yueh F, Singh JP, McIntyre DL, Jain J. *Appl Opt.* 2012 Mar 1;51(7):B149-54.
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- [8] Nany Elsherbiny O. Aied Nassef, Wavelength dependence of laser induced breakdown spectroscopy (LIBS) on questioned document investigation, *Science and Justice* 55 (2015) 254–263.