Real-Time Element Detection with Femtosecond Laser Induced Breakdown Spectroscopy

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Laser Induced Breakdown Spectroscopy (LIBS) is a powerful analytical technique used to determine the composition and characteristics of materials and samples. This method involves focusing high-intensity ultrashort nanosecond or femtosecond laser pulses onto the surface of a sample, generating a plasma that emits light containing spectral lines unique to the elements present in the sample. By analyzing these spectral lines, LIBS provides rapid, versatile, and detailed information about the elemental composition without the need for sample preparation, making it a highly efficient and non-destructive analytical tool suitable for a wide range of applications, including environmental monitoring, industrial quality control, and planetary exploration. This work focuses on the automation of the LIBS system used in the photonics laboratory of the São Carlos Institute of Physics through the development of a comprehensive program that integrates both hardware control and real-time spectral analysis. The system includes a set of three stepper motors that move the analyzed sample along three distinct axes to maintain the focus of the incident laser, ensuring consistent plasma generation across the sample surface. A spectrometer captures the emitted plasma light spectrum within the range of 200nm to 1100nm, covering a broad spectrum of potential elemental emissions. Using the Python programming language, a graphical interface was created to unify the control of the stepper motors and the spectrometer, allowing users to trace different trajectories along the sample surface while performing spectral analysis. Additionally, an algorithm was developed within this program to provide real-time element detection from the obtained spectrum. This was achieved by leveraging the extensive database of atomic emission lines provided by the National Institute of Standards and Technology (NIST) to simulate and fit the spectra of possible elements with efficient array libraries, ensuring millisecond-level analysis times.

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References

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