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Double-pulse laser induced plasma: Calibration-free laser-induced breakdown spectroscopy

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The laser induced plasma was generated on the surface of Gd-Ge-Si alloy and polycrystalline solar cells, using two Nd:YAG lasers, operating at 1064 nm. The plasma was diagnosed using plasma parameters such as electron temperature, electron number density and utilized in important analytical application known as Double-pulse Calibration-Free Laser-Induced Breakdown Spectroscopy (DP-CF-LIBS). The plasma parameters were used for the compositional analysis of standard Gd-Ge-Si alloy and polycrystalline solar cells, for which the inter-pulse delay, energy ratio between laser pulses, signal to background ratio and most importantly the validity of Local Thermodynamic Equilibrium (LTE) approximation were evaluated. The DP-CF-LIBS results of alloy were determined with and without using Boltzmann plots for all species, which show close agreement to the reference values. The analysis has been extended to three unknown polycrystalline silicon solar cells, which yield the concentration of silicon as 99.78, 98.09 and 99.45%, respectively. The trace impurities C, Ca, Sb, In, Sn, Ti, Al and K were detected in these solar cells and their concentration is listed. These impurities in crystalline structure reduce the conversion efficiency of solar cells and therefore their detection and quantification is very much required for efficient photovoltaic applications.

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