第77回応用物理学会秋季学術講演会 講演予稿集 (2016 朱鷺メッセ (新潟県新潟市))

Real-time detection of focal position for high precision laser micromachining

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The great global interest in laser micromachining and its commercial advantages have boosted laser engineers to create more flexible, effective, and versatile laser systems. The utilization of laser pulses has been demonstrated to be an outstanding approach in the excellent micromachining of many materials and capability to remove or vary material characteristics and can be popularly applicable. In this project, we presented a novel technique for real-time detection of focal point of specimen during laser processing using diffractive beam samplers (DBS) which can minimize the limitations of preexisted method such as low numerical aperture, dependence of sample surface toughness, and requirement of auxiliary laser source. This paper will exhibit the analytical model of the technique, the experiment of technique mechanism, and data analysis. The building of analytical model shows the participation of DBS into the detection system as the optical elements (optical system) and calculates the movement of specimen according to the movement of beam spots on the CCD camera that is used as an image detector. From that, we can determine the focal position in theory. The experiment of technique mechanism indicates the design of the detection setup including a DBS, beam splitter, objective lens, Silicon wafer (workpiece), and CCD camera, and tests the analytical model through the experimental data and simulation result, showing versatility of method. Finally data analysis evaluates the obtained data which was proved to be consistent with the breakthrough mentioned such as high numerical aperture (at this point, the numerical aperture of method is compared with the original numerical aperture of laser beam), independence of sample surface morphology, no requirement of several laser sources, and applicability for various types of laser. In summary, the method using DBS to detect focal point was declared to be a fantastic method to apply into laser micromachining and to design an autofocusing system in the near future.