Workstation for femtosecond laser machining

W. de Rossi, J. T. Vidal, L. M. Machado, R. E. Samad, A. Z. Freitas, and N. D. Vieira Jr.

Instituto de Pesquisas Energéticas e Nucleares – IPEN São Paulo SP – Brazil.

Machining of very small structures has been done with lasers using nano, pico and femtosecond temporal pulse widths[1]. Although longer pulses have thermal nature causing melting with dross formation and some heat affected zone, the possibility of higher average power make their use a good alternative for mass production. Otherwise very short laser pulses, in the femtosecond rang, can only be produced with average powers bellow 10 watts. This means that mass production can only be considered in very special cases, that is, when non-thermal machining is needed. This is the case where heat affected zone must be avoided and recast layer is difficult to be removed by reworking. Machining of semiconductors, electrical steels, and production of MEMS (micro electro-mechanical systems) and medical devices are some examples of such cases[2]. Thus, aiming production of such small structures a workstation was built with capability of controlling the main parameters needed to obtain micromachining in a wide range of materials and conditions.

Two main problems arise when considering such workstation: controlling of fluence and positioning. As it is well known, working in low fluence regime is essential to avoid thermal effects and so the control of beam focus diameter and energy must be done carefully. Precision in positioning is also a difficult task since vibration and uncontrolled beam steering is always present. Vibration is diminished by means of pneumatic pads in the working table and a fast steering mirror FSM. As the workstation is located 30 meters far from the laser source, any undesired beam movement is greatly magnified; the use of a position sensor near de beam focus can reduce such problem by correcting the position of a bending mirror close to the laser output. An aperture and a continuous beam profile measurement determine the diameter of the beam focus on the sample; a half wave-plate along with a Glan-Laser polarizer give an exact amount of energy deposited on the interaction area. Besides this control it is also necessary to know the threshold of ablation and regions of low and high fluence interaction for material to be machined. This was done with some metals and results are presented. Control of these parameters and use of a CNC-Cad Cam to command two linear stages allowed production of micrometric holes and structures in thin metal foils. Increase in production is obtained by working with low fluence only in the border of machined area while internal parts are machined in high fluence regime.

Keywords: Micromachining; Femtosecond laser machining, laser processing, laser ablation.
Work supported by CNPq – proc.: 470965/2006-1 and proc.:420156/2005-4

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e-mail: wderossi@ipen.br