Femtosecond Laser Ablation Characteristics and Machining Technology of Low Density 4-Methyl-1-Pentene Foam

Huang Yanhua
Research Center of Laser Fusion, China Academy of Engineering Physics, *Mianyang* 621900, China

Abstract :Poly-4-methyl-1-pentene (PMP) foam has now become one of the most widely used low-density porous materials for inertial confinement fusion (ICF) experiments[1,2]. Foam target elements for laser fusion experiments may be membrane shaped, cylindrical, spherical, or more complex, depending on the type of experiment for which they are designed. The size of the targets varies from a few centimeters to a few hundreds of microns. For target shaping two approaches exist[3]: either machining or direct molding. For complex shapes or membranes, machining is not appropriate; therefore, the shaping procedure is always chosen according to the desired geometry and the aimed density. The lower the density, the weaker is the mechanical strength and vice versa. Ultralow density (<20mg/cm^3) foams cannot be machined mechanically because they collapse under the lathe tool. [3] Femtosecond laser machining technology possesses the ability to machining ultralow density foam， because the ultra-short high energy laser pulses offer many advantages, which include precise ablation of materials without significant heat affected zone, and without forces on materials.

In this paper, Femtosecond laser ablation of two kinds of PMP foam was experimentally studied with laser pulse width 50 fs at a center wavelength of 800 nm and the repetition rate was 1 kHz for micro-machining applications. The impacts of laser power and the pulse number on the crater diameter were obtained. And the influences of laser power and cutting speed on cutting width were get，too. A processing technology combining scan cutting with scan thinning to produce foam sheet was presented. PMP foam sheet whose thickness is less than 100μm can be produced by the method. The results show that femtosecond laser processing technology can be used for machining low density foam material micro parts.

Key words: Femtosecond laser； Foam； Machining； Target

[1] Keiji Nagai, H. Azechi, F. Ito, A. Iwamoto, Y. Izawa, T. Johzaki, R. Kodama, K. Mima, T. Mito, M. Nakai, N. Nemoto, T. Norimatsu, Y. Ono, K. Shigemori, H. Shiraga and K. A. Tanaka. Foam materials for cryogenic targets of fast ignition realization experiment (FIREX). *Nucl. Fusion* 45 (2005): 1277-1283

[2] Zhang Lin, Wang Chaoyang, Luo Xuan, *el ta*. Development on the fabrication of ultra-low density ploy(4-methyl-1-pentene)(PMP) foams by thermal induced phase-inversion technique. *China Nuclear Science and Technology Report*, 2003, (01): 130-143

[3] Grosse M, Guillot L, Reneaume B, et al. TPX foams for inertial fusion laser experiments foam preparation, machining, characterization, and discussion of density issues[J]. Fusion Science and Technology, 2011, 59:205-215.