

# Spectroscopic study of laser-supported absorption waves

P. S. P. Wei\*\*

(Boeing Aerospace Co.)  
Seattle, Washington

The absorption of laser radiation at power densities between  $10^6$  to  $10^8$  W/cm<sup>2</sup> by solids may lead to surface evaporation, plasma production and air breakdown. In this paper we review the progress on plasma diagnostics using space-and time-resolved spectroscopy in the UV-visible range. Three types of lasers (CO<sub>2</sub>, HF, and Nd) with pulse durations between 10- $\mu$ sec to 1-msec are used. At a higher power density, the ionized-air plasma (which contains mainly N<sup>+</sup> and O<sup>+</sup>, with T<sub>e</sub>=1 to 3 eV and N<sub>e</sub>= $10^{17}$  to  $10^{18}$ /cm<sup>3</sup>) absorbs laser photons by inverse-bremsstrahlung and proceeds towards the laser at a supersonic speed. Under a partial vacuum behind the shock-front, we find that the ejection speeds of evaporated target species follow a 3-dimensional Boltzmann model that  $v_{rms}=(3RT/M)^{1/2}$  where T is the boiling temperature of the solid and M is the atomic mass. In the plasma plumes from targets containing Al, B and C, we observe prominent molecular bands such as AlO, BO, and CN. Due to the plasma Stark effect, electric-dipole forbidden transitions in atomic Al are detected. The results<sup>1</sup> will be discussed with regards to laser-target coupling near the threshold of surface-induced air-breakdown. Comparisons will be made with plasmas from electrical discharge.

\*\* Collaboration with R. B. Hall, W. E. Maher, D. J. Nelson, D. B. Nichols, and K. T. Tang is gratefully acknowledged.

1. P. S. P. Wei, J. Appl. Phys. 48, 4196 (1977); and Bull. Am. Phys. Soc. 23, 893, 9F8 (1978).

## 激光维持的吸收波的光谱学研究

P. S. P. Wei

(波音航空公司)

在功率密度为  $10^6 \sim 10^8$  瓦/厘米<sup>2</sup> 的激光辐照下, 固体对激光辐射的吸收可能导致表面蒸发、产生等离子体和空气击穿。本文中我们评述用紫外到可见波段空间和时间分辨的光谱学方法对等离子体诊断的进展。使用三种类型的激光器(CO<sub>2</sub>、HF 和 Nd), 脉冲持续时间为 10 微秒到 1 毫秒。在高功率密度下, 电离的空气等离子体(主要包含 N<sup>+</sup>和 O<sup>+</sup>, T<sub>e</sub>=1 到 3 电子伏和 N<sub>e</sub>= $10^{17}$  到  $10^{18}$ /厘米<sup>3</sup>) 经逆韧致辐射吸收激光光子并以超声速趋向激光方向。在冲击波波前之后有部分真空下, 我们发现, 几种蒸发的靶材的喷射速率遵从三维玻尔兹曼模型—— $V_{均方值}=(3RT/M)^{1/2}$ , 式中 T 是固体的沸点温度, M 是原子质量。在包含 Al、B 和 C 的靶材的等离子体羽中, 我们观察到象 AlO、BO 和 CN 这种显著的分子带。由于等离子体的斯塔克效应, 在原子 Al 中检测到电偶极禁戒跃迁。在表面感应空气击穿阈值附近, 就激光与靶的耦合情况讨论了这些结果。并与放电产生的等离子体进行了比较。