

Electron beams for e-beam lasers

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The development of high energy, high power lasers has been synonymous with the development of electron beams. The application of electron-beams to laser systems has been varied but can in general be grouped into three specific areas:

1. Direct excitation, including pumping by cascade electrons and transfer molecules.
2. Discharge sustainer where the electron beam provides the electrons required to maintain a stable discharge.
3. Free electron laser where the beam itself is the lasing medium.

The type of electron accelerator used to produce the beam necessary for the first two applications are similar although their intensities differ by least an order of magnitude. They are generally potential drop accelerators where the electrons are generated at a large negative potential and accelerated to ground. The electron emission is from either thermionic or plasma sources of various types. Beam current control is generally accomplished by space charge in either diode or triode configurations. Temperature limited emission has also often been used. Very large scaling of these accelerators has taken place (beam area, current density and beam kinetic energy).

Accelerators required for free electron lasers (FEL) are often of a different type. This is a result of the beam kinetic energy of 5 to 100 MeV required of FEL's in comparison of the 0.1 to 1.0 MeV required of the first two types. In order to achieve the high energy beams, linear accelerators (either microwave or induction) are used. Future scaling of accelerators for FEL's will not be in beam area but in average power and peak current while maintaining a small emittance and energy spread in the beam.

电子束激光器的电子束

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高能、高功率激光器的发展与电子束的发展已经同义。电子束在激光系统中的应用已有多种,通常可分为三种特殊领域:

1. 直接激发,包括级联电子和转移分子的泵浦。
2. 放电持续器,其中电子束提供维持稳定放电所要求的电子。
3. 自由电子激光器,其中电子束本身就是激光介质。

产生前二种用途的电子束加速器类型相同,然而,强度有数量级之差。通常是电位降加速器,在大的负电势下产生电子,并加速到地电位。电子辐射起源于热电离的或各种类型的等离子体源。一般由二极管或三极管结构中的空间电荷控制电流,也常用温度限制辐射。这类加速器已有很大的规模(包括束面积、束流密度和电子能量)。

自由电子激光器所需的加速器则不同,它需要5—100兆电子伏的电子能量,而前二种用途的电子能量为0.1—0.1兆电子伏。为获得高能电子束,使用直线加速器(微波或感应)。未来的自由电子激光器的加速器规模将不在于束流面积,而在于保持低辐射强度和小能量分布条件下的平均功率和峰值电流。