Energy deposition in electron-beam pumped gas lasers

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Electron-beam used as a pumping source is a relatively new and more difficult technique in the field of gas laser. In designing this type of lasers, the best utilization of this technique and the maximization of the energy deposited into the gases are of major concern. Nevertheless, most of the literature are devoted not to the above problems, but to other such questions as the kinetic processes in the active medium pumped by e-beams and the parameters of optical resonators. But, it is fair to say that the energy deposition is one of the fundamental factors for estimating the laser efficiency which, in turn, is used as a criterion for the determination of optimum parameters of the lasing medium and optical cavity. Its calculation is imminent because there are no such calculation formulas available at present. In this paper we present these calculation formula. Numerical calculations have been made for several typical laser systems using numerical results of stopping capabilities given by Berger and Seltzer. Our results are in accordance with theirs.

The relationship between energy deposition and various parameters are discussed based on these formula.

The effectiveness is compared for the best utilization of the initiated energies of e-beams in several pumping configurations, e.g., e-beam transverse pumping, e-beam longitudinal pumping, and e-beam pumping of ultra-high pressure gases.

An effective method is proposed in this article which deals with the spiral movement of electrons under the action of an external magnetic field, with an increase in energy deposition and laser output energy.

The calculation methods, figures and curves are also applicable for other gas laser systems.

电子束泵浦气体激光器中有关能量沉积的讨论

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在气体激光领域内采用电子束作泵浦源是一门比较新型的技术，也是一项难度较大的技术，如何最佳地使用这种技术，如何使电子束沉积在气体中的能量最大，都是设计这类激光器必须关注的问题，但是许多文献一般很少论述这些问题，而多半偏重于论述电子束泵浦激射物质的那些动力学过程和光学谐振腔参量等问题，然而能量沉积是估算激光器效率的一个基本参量，激光器效率又是衡量激射物质和光学谐振腔是否达到最佳参量的依据，因此计算电子束能量沉积乃是一个迫切的问题，目前尚未看到计算这类激光器能量沉积的公式，本文给出了这方面的计算公式，利用 Berger 和 Seltzer 给出的阻止本领的数字表，对几种典型的激光器进行了数字计算，所得结果与原作者的计算值一致。

围绕上述计算式还讨论了能量沉积与各参量的关系，并对几种泵浦形式如电子束横向泵浦、电子束纵向泵浦以及电子束泵浦特高气体等在最有效地利用电子束初能方面作了比较。

文中还论述了电子在外加磁场的作用下，电子作螺旋运动，可增加能量沉积，从而提高激光输出能量的有效方法。

文中给出的计算方法和图表曲线不仅适用于文中所列举的例子，而且对其他气体激光器也同样适用。