

超快激光内部改质切割碳化硅晶圆的球差校正研究

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碳化硅 (SiC) 做为第三代半导体材料, 由于其具有禁带宽度大、高导热性、高电子饱和速率和化学性质稳定等优良特性, 在电子信息、新能源汽车、5G 通信技术等领域有着重要的应用前景, 有望取代 Si 成为制备高功率、耐高温和抗辐射半导体功率器件的主要材料。晶圆切割是 SiC 半导体功率器件制造流程中的重要工艺环节, 激光内部改质切割技术由于其具备切割质量好、切割效率高和无接触切割等优势, 广泛应用于半导体晶圆切割领域。然而, 在激光内部改质切割过程中, 激光经聚焦物镜聚焦再通过空气射入 SiC 内部, 由于空气与 SiC 折射率不匹配而引起球差, 导致激光光束的汇聚程度与能量分布发生变化, 影响了 SiC 晶圆切割的切割质量及切割效率。本文通过对球差产生原因及机理进行分析, 提出了新的方法来校正由于折射率不匹配形成的球差。该方法利用切趾函数将激光光束分为不同直径, 对不同直径的激光光束进行球差校正可以得到相应的球差校正相位图。再利用空间光调制器对 SiC 内部进行了球差校正实验, 校正后的激光光束的汇聚程度与能量分布得到了很大的改善, 同时 SiC 晶圆切割的切割质量及切割效率也得到了极大的提高。该球差校正方法一般适用于高 NA 值物镜聚焦在材料深处。

关键词 : 激光内部改质切割; SiC 晶圆; 激光功率密度; 空间光调制器; 球差校正

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