Investigating the Impact of Ultraviolet Laser Parameters on the Surface Characteristics of Silicon Carbide (SiC) Substrates

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Silicon carbide (SiC) is a third-generation semiconductor material and known for its high-temperature resistance and wide bandgap characteristics. However, the poses challenges of SiC process was the inherent hardness, and it makes traditional grinding and polishing time-consuming and resource-intensive, then significantly elevating wafer production costs. Laser systems can be applied for material marking, drilling, cutting, and surface modification. In previous studies, several research presented that the femtosecond [1-2] and nanosecond [3] laser system was employed to ablate and polish the SiC surface, wherein the influence on surface roughness, ablation depth and oxidation of SiC have been computed. Therein, the laser parameters such as pulse energy, spot overlapping and defocus of laser spot were investigated. Furthermore, some studies discuss effect of the laser ablation and polishing for the following chemical-mechanical polishing (CMP) [4-5] process. It is noteworthy that the majority of these studies employed femtosecond laser systems, but the system price of femtosecond laser was too high to be widely applied in the SiC manufacturing facilities. Therefore, the suitable laser treatment mechanism on SiC substrates was investigated in this manuscript, and the parameters such as the scanning speed, pulse repetition frequency, laser path and repetition times of laser system can be adjusted to find the suitable values for soften the hardness of SiC substrates. In this study, the ultraviolet laser system was employed to modify the characteristics of SiC surface. We investigated the effects of different processing path, speeds, frequencies, and power levels on modification depth, oxidation, and hardness changes in the SiC surface. By inducing the surface softening, the goal is to enhance the efficiency of subsequent CMP process. Preliminary test results indicated that laser treatment of SiC surfaces leads to the formation of oxides, causing the surface hardness to reduce to approximately 30% of the original value. This reduction facilitates subsequent CMP processes, accelerating material removal rates and minimizing tool wear. The development presented in this research has the potential to increase SiC wafer productivity and reduce production costs.

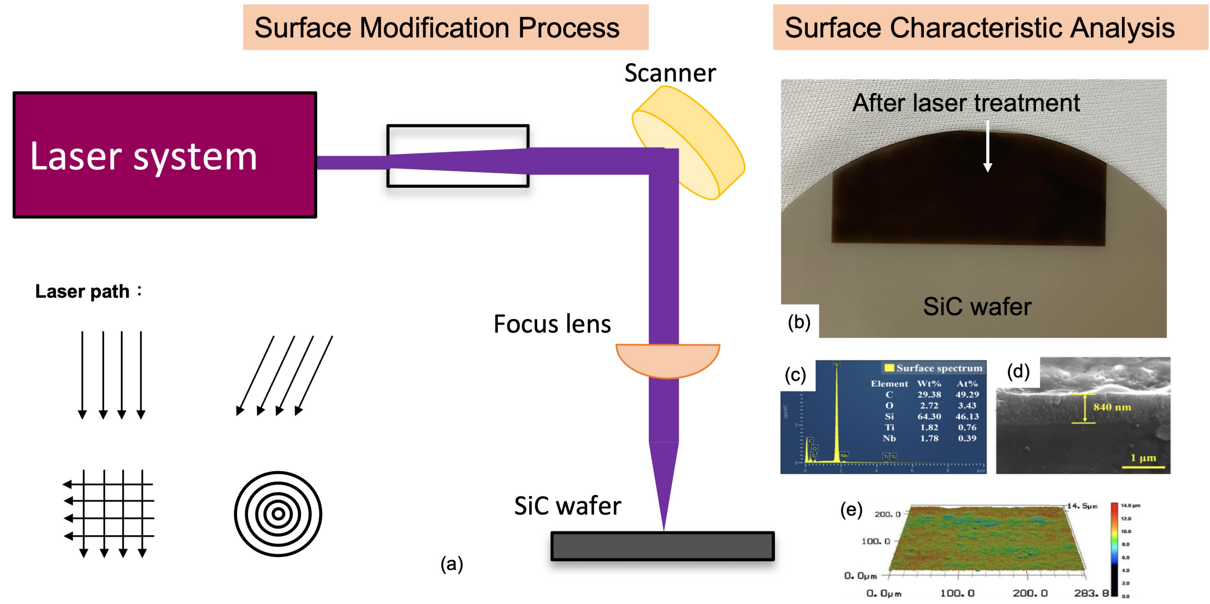

Figure 1: Schematic of (a) experiment setup and laser path on SiC wafer, (b) SiC profile before and after laser treatment, and the surface characteristics analysis included (c) composition analysis (oxygen content), (d) Surface topography (thickness) and (e) surface roughness.

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