

Article

An Experimental Investigation on the Cutting Quality of Three Different Rock Specimens Using High Power Multimode Fiber Laser

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Abstract: The laser cutting of rock has been popular recently because of its advantages over traditional rock cutting methods. Several types of research were performed to replace traditional rock cutting techniques with laser cutting. The purpose of this experiment is to observe cutting quality for intrusive igneous rocks using a high-power multimode fiber laser. The cutting quality, in terms of kerf width and penetration depth, resulted from different scanning speeds and was studied and compared. The specimens used in this study were gabbro, granite, and diorite, which are widely applied in the construction industry because of their high compressive strength and beautiful textures. Energy-dispersive X-ray Spectroscopy (EDX) analyses were conducted to observe the chemical content of three different areas, the melting area, the burnt area, and a non-processed area, for each rock specimen. The study of the compositional changes in each area will also go over the cutting quality of each rock specimen at different scanning speeds. According to the experimental results, the kerf widths of the specimens gradually decrease as the scanning speeds increase. The penetration depths into the specimens sharply decrease as scanning speeds increase. From a study of their compositional changes, it is found that the cutting quality for each rock depends on their silica content. This study summarizes that the cutting quality for a rock specimen greatly depends on the scanning speed of the laser cutting.

Keywords: laser cutting; intrusive igneous rocks; multimode fiber laser; kerf width; penetration depth; scanning speed

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1. Introduction

Due to their useful applications and beautiful textures, igneous rocks are used for many interior decorations and furniture. Moreover, they are used in the heavy construction industry because of their hardness and high strength. Igneous rocks are the most basic type of rocks, formed from the solidification of magma. They are divided into two groups, according to the different magma solidification locations. Intrusive igneous rock is formed from magma solidification beneath the Earth's upper layer and extrusive igneous rock is formed from magma solidification above the Earth's surface [1–3]. The two types of igneous rocks have different chemical compositions and different structural arrangements; thus, they have different application areas. Extrusive igneous rocks are commonly used as aggregates for concretes. In contrast, intrusive igneous rocks are used for interior decorations, kitchen countertops, and in art galleries [3–5]. The most commonly used intrusive igneous rocks are gabbro, granite, and diorite. They are classified according to their different silica contents in the bulk rock composition. Gabbro contains up to 53 wt.% of silica, granite is made up of around 75 wt.% of silica, and 63 wt.% of silica can

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