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Preparation for Megawatt-range Trials at 3 GHz: A Preliminary Study of Rocks Comminution with Very High Pulsed Microwave Power

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Summary

This abstract presents an optimized microwave assisted rock breakage system using a 7.5 megawatts microwave power source at 3 GHz. To provide an efficient electromagnetic field inside the rock samples a TM010 single mode cavity is designed and fabricated at 3 GHz. The designed cavity is measured and its frequency response (S11) at 3GHz is -17dB.

1. Introduction

The mining industry is one of the most energy-consuming industries. The process of breaking down rock to extract minerals, as a crucial part of the mining industry is a major consumer of electrical energy and accounts for a significant portion of operating costs in mining. Therefore, the development of highly efficient crushing methods has become an essential aspect of this industry to reduce energy consumption and operational costs. Microwave assisted rock breakage is a promising method for improving the efficiency of comminution in the mining industry. This method involves exposing rock to high-power microwave sources, which generates thermal stress and causes the rock to fracture [1]. The main sections in a microwave assisted rock breakage system are a microwave power source and a microwave cavity. So, many kinds of microwave assisted rock breakage systems have been proposed based on different microwave cavities in a wide range of resonant frequencies with different microwave power levels [1]-[3]. To improve the efficiency of the microwave assisted rock breakage, we proposed a TM010 single mode cavity at 3 GHz. Also, the proposed system uses a 7.5 megawatt klystron microwave power source.

2. Microwave assisted rock breakage setup

To reach an optimized system for rock breakage using microwave power, we introduce the illustrated structure in Figure 1. This system consists of a 7.5MW Klystron microwave power source (RF Source), microwave applicator (Rock cavity), and microwave components for irradiating energy inside the cavity. In this microwave setup, the microwave applicator plays a key role in obtaining maximum electromagnetic field inside the rock samples. Hence, designing an efficient microwave cavity is important in a microwave assisted rock breakage system.

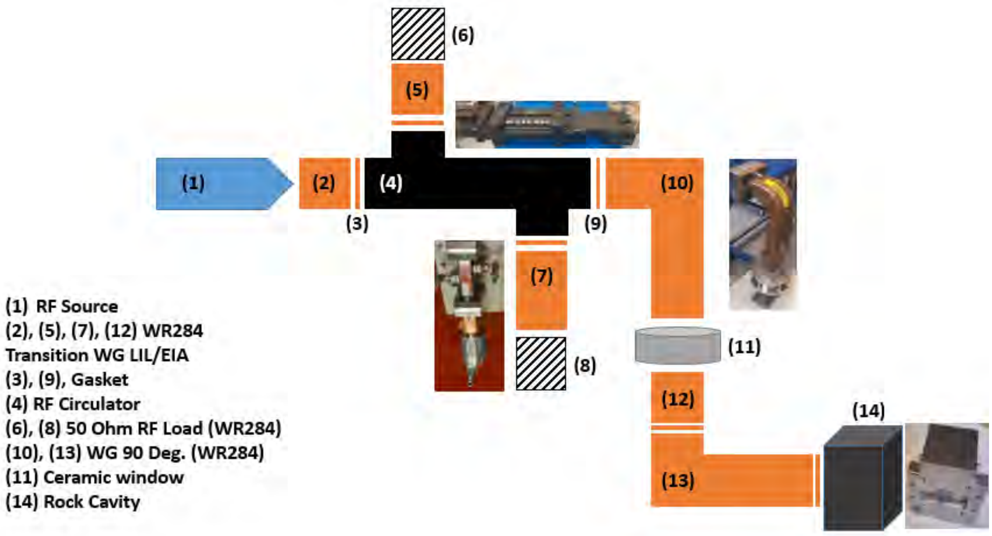

Figure 1. Proposed optimized system for rock breakage using microwave power.

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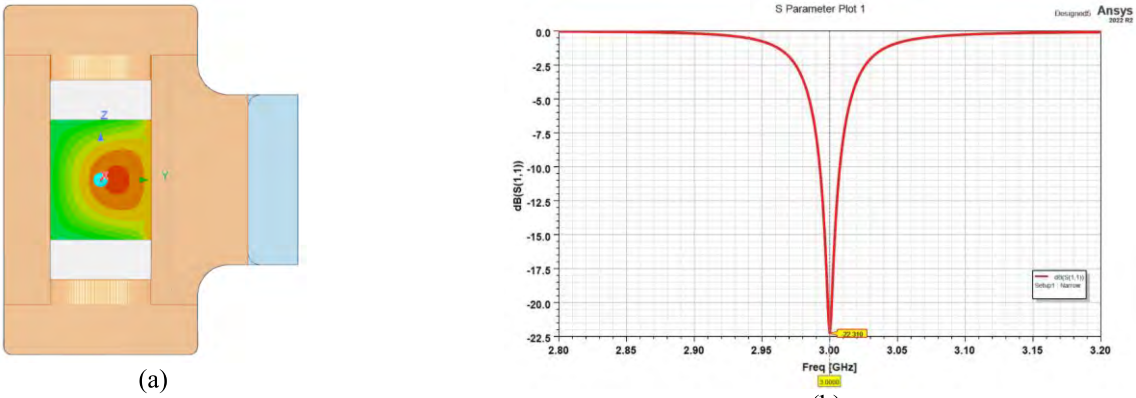
3. Design and simulation of the microwave cavity

We design a TM010 single mode cavity at 3 GHz as an efficient microwave applicator. The designed cavity is shown in Figure 2.a. The rock sample which is placed in the middle of the cavity using a dielectric holder. The designed cavity is simulated using HFSS software and its E-field and frequency response (S11=-22dB) are illustrated in Figure 2.b.

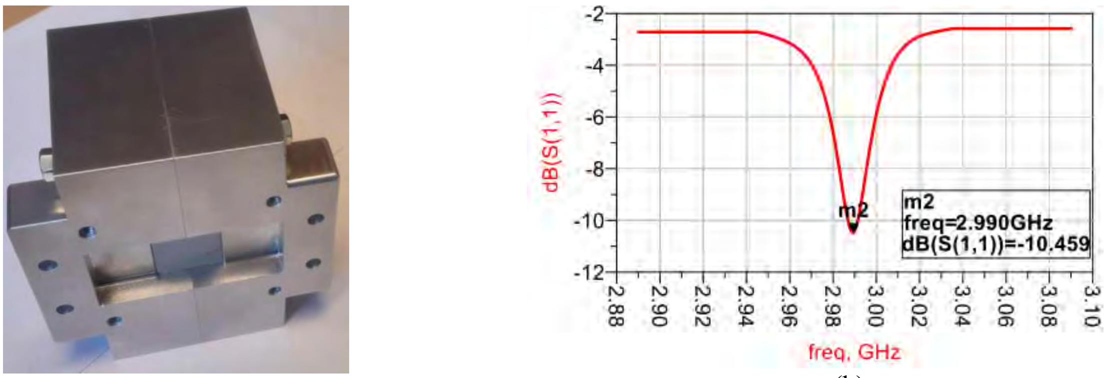


(a) (b)

Figure 2. (a) Designed TM0101 single mode cavity and E-Field distribution inside the rock sample (b) Frequency response (S11) of the designed cavity

4. Experimental results of the microwave cavity

The fabricated cavity is illustrated in Figure 3.a. Also, the frequency response (S11) of the cavity is measured using the network analyzer and experimental results are shown in Figure 3.b.



(a) (b)

Figure 3. (a) Fabricated TM010 cavity (b) Measured frequency response (S11)

5. Acknowledgements

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