Fact Sheet

RADAR SIGNATURE OF SIMULANT MINES (SIMs)

BACKGROUND

Simulant mines (SIMs) are standard test targets developed by the U.S. Army Project Manager-Mine, Countermine and Demolitions (PM-MCD) and VSE Corporation to test and evaluate mine detection equipment. SIMs are filled with RTV silicone rubber, which has electrical and thermal properties similar to TNT and Composition B, and therefore interact with radar and infrared detection sensors in a way representative of live mines. Metal inserts that simulate the metal parts of low-metal-content mines can also be used to evaluate metal-detecting sensors.

We are currently using SIMs to investigate the environmental impact on radar and infrared detection of buried land mines. As a first step, the radar signatures of SIMs in free space were measured using a network-analyzer-based radar system. These measurements will serve as a baseline to determine the degradation of radar response of buried SIMs under adverse environmental conditions.

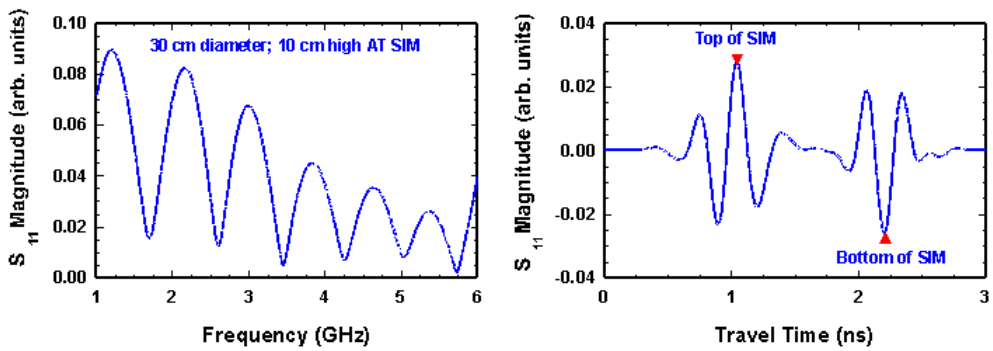

Figure 1.

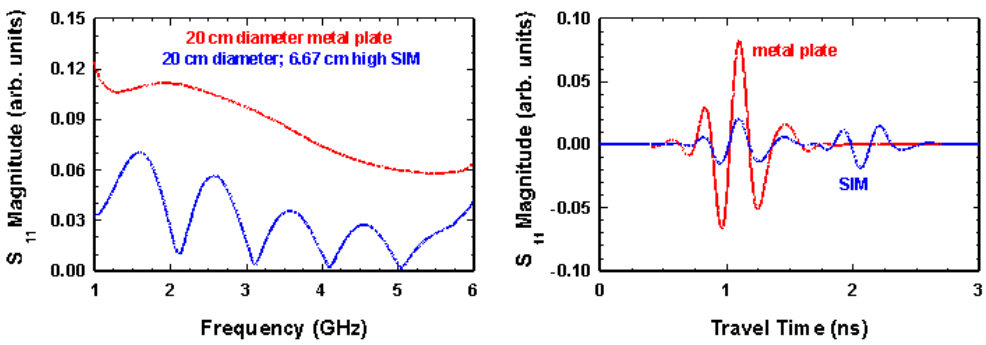

Figure 2.

EXPERIMENT

The radar signatures of the SIMs were obtained with an HP8753E network-analyzer-based radar system. |The measurements were made at frequencies ranging from 1 to 6 GHz, at normal incident angle, with the SIMs located 30 cm from the base of the antenna. Figure 1 shows the frequency and time domain signatures for a 30-cm-diameter, 10-cm-high anti-tank (AT) SIM. The frequency domain response illustrates the interference pattern characteristics of 10-cm-thick AT SIMs. (The decrease in reflectance as a function of frequency is attributed to the antenna response, rather than the SIM response.) The time domain response shows the phase reversal as the radar signal passes through the SIM. (Based upon the two-way travel time of 1.17 ns, the dielectric constant of SIM was determined to be 3.1.) Figure 2 compares the response of a 20-cm-diameter, 6.67-cm-high AT SIM with a similar-sized metal plate. The characteristic frequency and time domain signals expected from nonmetallic mines are again illustrated.

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SUMMARY

Baseline measurements of radar response from SIMs were obtained. The results suggest that frequency and time domain signatures may be used to discriminate low-metal-content mines from background clutter such as rocks. In the frequency domain, analysis of the interference pattern (locations of maximum and minimum) may be a useful discrimination tool. If the dielectric constant of the surrounding soil is known, then phase reversal measurement in the time domain may also be a useful discrimination tool.

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