

Antenna Aperture-Shared Low-Pass Radar Absorbing Metasurface for Stealth Applications

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In modern warfare, the increasing importance of Electronic Warfare (EW) has led to a growing demand for low-observable and stealth technologies. Antennas play an essential role in wireless communication for military applications. However, the large conductive surface of antenna aperture for lower operation frequencies significantly affects radar cross-section (RCS) performance of higher frequency range. To address this issue, numerous studies have focused on integrating radar-absorbing metasurfaces with antennas. Nevertheless, such integrated designs often result in degraded antenna performance, making it challenging to implement effective RCS reduction techniques. Moreover, the integrated designs demand changes to both the radar absorber and antenna design when modifications are required, leading to inefficiencies in the design procedure. This paper presents designing an antenna aperture-shared low-pass radar-absorbing metasurface that addresses these challenges. The proposed metasurface allows for the transmission of low-frequency signals below 1 GHz while effectively absorbing radar waves in the X-band frequency range. Suggested design enables the placement of the radar absorber independently of antenna locations, thus maintaining antenna performance while achieving significant RCS reduction at X-band more than 10 dB. The radar absorber is designed as a sandwich structure to ensure mechanical stability and consists of two metasurfaces: a low-pass ground metasurface and a resistive metasurface for radar wave absorption. This dual-layer configuration allows for efficient signal transmission at lower frequencies while providing effective absorption in the desired radar frequency range. The design and analysis of this structure were conducted using CST software, with measurement validation performed using Free-space measurement equipment. Simulated and measured results show that the ground metasurface exhibits an insertion loss of less than 1 dB below 1 GHz while showing quasi-PEC (Perfect Electric Conductor) properties in the X-band. These characteristics make it suitable for use as a ground plane in radar absorber design. The combination of low-pass feature and X-band absorption offers a versatile solution for enhancing stealth capabilities without compromising low-frequency antenna functionality. This research contributes to the field low-RCS technologies by providing a radar absorber design that can be applied independently of existing antenna systems. The proposed metasurface design offers potential applications in various military platforms where both low-frequency communication and radar stealth are critical. This work was supported by the Defense Acquisition Program Administration and the Korea Research Institute for Defense Technology under the contract KRIT-CT-23-046

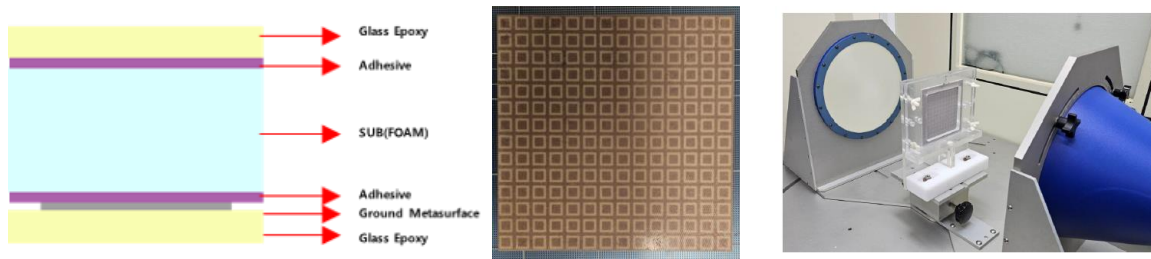


Figure 1. Ground metasurface Fabricated sample and measurement setup