# Electromagnetic Scattering Characteristics of Rough PEC Targets in the Terahertz Regime

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***Abstract*—A hierarchical semi-deterministic modeling and computation method was proposed to deal with the scattering problems of rough PEC targets at terahertz frequencies. The scattering fields and imaging results of several cubes with different surface characters were obtained. The influence of surface roughness can be easily observed.**

## I. INTRODUCTION

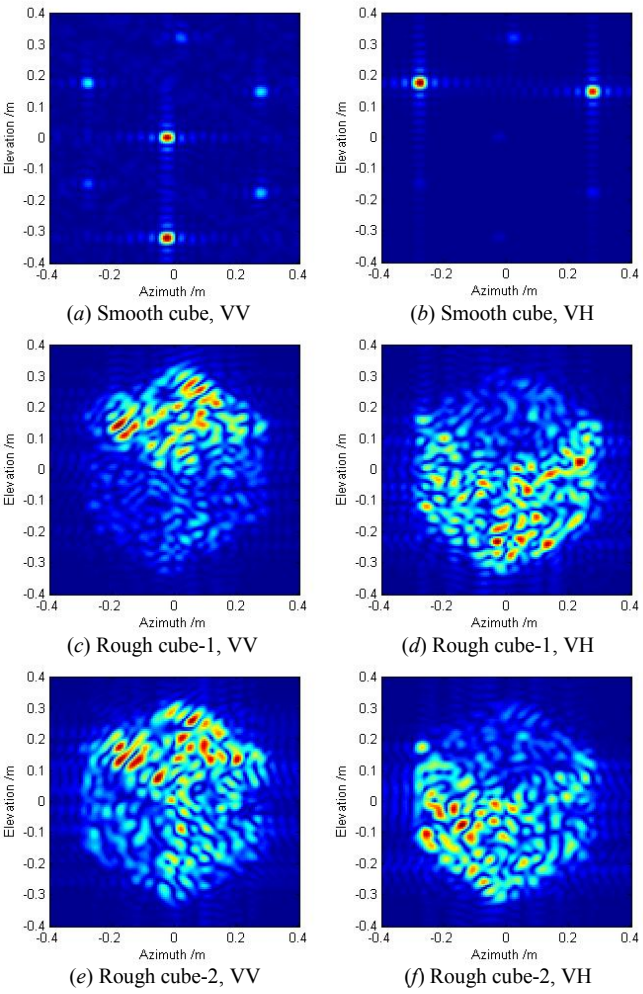
Scattering characteristics of targets at terahertz frequencies are one of the preconditions while taking advantages of terahertz wave for active detection. Recently, several researchers have investigated the targets' electromagnetic scattering characteristics in the terahertz regime and got significant achievements[1][2]. These studies inherited the hypothesis that the targets' surfaces were perfectly smooth which was usually reasonable at microwave frequencies. Unfortunately, this important hypothesis is always invalid as the wavelength goes extremely small and gets approach to the tiny roughness on the surface. Experiments have shown that terahertz waves scattered from rough surface show obvious distinctions comparing with that from smooth surface[3]. How to take the effects of surface roughness into consideration while computing the electromagnetic scattering fields remains to be a problem.

The Method of Moments is no longer considered to be a competitive candidate for EM computation because of the dramatically increasing of memory requirements and computational complexity in the terahertz regime. To date, most of the researchers utilize high-frequency methods based on Geometrical Optics(GO), Physics Optics(PO) and Shooting and Bouncing Ray(SBR) technique for the problems of terahertz scattering. But these methods' efficiency and accuracy rely on the smooth surface assumption and few work has been done concerning the surface roughness.

This paper presented a hierarchical semi-deterministic modeling and full-wave-algorithm(FWA) based computation method[4] that considered the surface roughness as well as took care of the cost of memory and computational complexity. As the diffraction component of the scattered field is in inverse proportion to frequency, we haven't count the contribution from edges yet.

## II. RESULTS

The amplitude, phase and polarization information of both monostatic and bistatic scattering fields from rough PEC targets can be obtained by the proposed method. The calculation results can support the research of radar imaging or the research of RCS. We took PEC cubes with 40cm-edges as an example. The VV- and VH-polarized monostatic scattering waves were calculated within small sweeps of both azimuth and elevation observation angle at 300GHz. And the radar images were obtained using the synthetic aperture technology. Figure 1 shows the imaging results. As can be seen, the images of rough cubes differ from those of smooth cubes greatly. And different roughness parameters also lead to obvious differences of the images.




(*a*) Smooth cube, VV (*b*) Smooth cube, VH

(*c*) Rough cube-1, VV (*d*) Rough cube-1, VH

(*e*) Rough cube-2, VV (*f*) Rough cube-2, VH

**Fig. 1.** Observation angle: $(\theta,\varphi)=(54.5^\circ\sim55.5^\circ,49.5^\circ\sim50.5^\circ)$. The RMS height and correlation length of rough cube-1 were $\lambda/8$ and $\lambda$. The RMS height and correlation length of rough cube-2 were $\lambda/8$ and $\lambda/2$.

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