Near-field scattering from a class of rough surfaces

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A perfectly conducting (PEC) rough surface scatters specularly to the far field when its height function has spectral content only at surface wavelengths shorter than half an electromagnetic wavelength. This is so, even though an incident electromagnetic field induces different currents on the rough PEC surface than on a flat PEC surface of the same mean height. To sense remotely the difference between such a rough surface and a flat surface is not easy. The near field scattered from the rough surface however does differ from the near field scattered from the flat surface. The question is: how near?

This paper investigates the transition from the near-field region to the far-field region during scattering from rough surfaces of the kind suggested. Illuminating rough and flat surfaces each by a Thorsos taper and an unbounded plane wave, the paper finds the near-field scattering region above a short-period sinusoidal surface to be restricted to quite a thin layer, whereas it discovers the corresponding layer above a random surface—the layer in which the short surface-wavelength components of the surface spectrum can potentially be sensed—to be much thicker.

Such characterization of the near field potentially impacts applications such as near-field spectroscopy. This is interesting in itself, but the scattered radiation has at least one attribute which carries even to the far field: polarization. The addition of short spectrum at sufficiently large amplitudes to a PEC surface alters the phase of the field the surface scatters differently for one polarization than for the other. Such differential phase alteration, or ellipticization, may offer a way remotely to detect the presence of certain kinds of surface features otherwise not easy to detect.