Authors' response — The purpose of the paper[1] that has elicited the above comment was to test the specific predictions of the composite diffracted evanescent wave (CDEW) model[2] of optical response to subwavelength structures and thereby assess the model's validity. These tests were carried out by measurements of the optical response of very simple one-dimensional subwavelength slit–groove structures milled in a silver film. The essential surface-wave properties of amplitude, wavelength and phase at the silver–air interface as a function of slit–groove distance were measured by detecting transmitted interference fringes in the far-field.

The authors of the comment first question the appropriateness of a scalar model to describe phenomena dependent on the polarization of the incident light. The CDEW model is based on an analytic solution[3] to the two-dimensional scalar Helmholtz equation subject to Rayleigh–Sommerfeld boundary conditions on an opaque screen with negligible thickness and one slit opening. It is well known that in two dimensions the vector electromagnetic fields satisfying Maxwell's equations separate into two two-dimensional fields characterized by transverse electric (TE) and transverse magnetic (TM) polarization[4]. Fields of TE, TM or any linear combination of these polarizations can be found that satisfy the scalar Helmholtz equation. The specific polarization of the incident field therefore is a matter of choice. In the actual experiments, the opaque screen of the CDEW model is replaced by a highly conductive metal with finite thickness. It is a well-known physical fact that in order for such a structure to transmit light and generate surface waves the incident beam must be polarized TM. Therefore TM polarization is the appropriate choice on physical grounds for the wave solutions to the Helmholtz equation. Once this choice is made the electromagnetic field is completely specified. Although, as the authors of the comment point out in their Fig. 1a, this choice does not include an electric field component E_z required for a surface evanescent mode, neither does TE polarization at normal incidence; and yet transmission through the slit and surface wave excitation are highly selective for TM. The explanation is that the orientation of the tangential components of the incident electric field are not directly responsible for the structure's optical response. Surface waves are generated by local charge accumulation from strong induced current gradients in the metal surface at the slit and groove edges[5]. These surface current gradients deposit charge at the structure edges much more efficiently when the tangential **H** field aligns along the long axis of the slit and groove (TM polarization). Significant E_x and E_z field components at the surface, necessary for driving evanescent surface waves, arise from these deposited charges. For TE polarization, weak surface current gradients and field continuity conditions through the air–metal boundary result in a very small amplitude for the surface electric field (for a perfect conductor it would be null). In contrast, Ampère's law stipulates that H_y (TM polarization), supported by strong surface currents, can be discontinuously large just above the boundary.

Contrary to the assertion of the comment, the CDEW model is not constructed by "arbitrarily" only taking evanescent modes into account. The CDEW model is an application of the angular spectrum of plane-waves analysis[6] to transmission through the opaque-screen-slit problem. At the surface this angular spectrum contains inhomogeneous (evanescent) components and homogenous (propagating) components. Each of these mode classes are solutions separately of the Helmholtz wave equation. The Rayleigh–Sommerfeld boundary condition of the first kind requires that the net field be zero at the opaque surface and equal to the constant, incident field in the slit; and therefore requires cancellation of the evanescent and propagating modes on the opaque surface. However, the Rayleigh–Sommerfeld condition is only a choice dictated by simplicity and physical plausibility, not an intrinsic feature of the CDEW model. Kowarz himself considered this choice of boundary condition only approximate[3]. In fact we now know from both experiment[1,7] and numerical studies[8–10] that the field on the surface is not zero but can and does support many surface modes including the bound surface plasmon polariton (SPP) mode. For the angular spectrum analysis the choice of the SPP mode as a surface boundary condition would be as valid as the zero-field condition; and, in the case of a metal–dielectric interface, a physically more accurate choice. As the experiments show[1,7], with the Rayleigh–Sommerfeld boundary condition, the CDEW model fails in the 'far-zone' asymptotic region beyond a slit–groove distance of about 4 μm. In this far zone the surface supports the bound SPP whereas the CDEW model predicts near-zero surface wave amplitude. However, in the 'near zone' out to about 3 μm slit–groove distance the CDEW model includes the presence of the many other surface evanescent modes that must be present to ensure correct field matching across the boundaries at the slit and groove. These modes are not bound; they dephase and dissipate within the near zone. But in the near zone they are at least as important to the net field composition as the bound SPP. The superposition of these ephemeral evanescent modes to produce the composite surface wave is the essence of the CDEW model and the reason it yields results in accord with experiment within this near zone.

This model certainly cannot claim to capture all the physics of light transmission in real structures. In particular the infinitely thin slit simplification is a serious deficiency. Nevertheless it is useful because it emphasizes that any theory purporting to explain the physics of light transmission through planar arrays with subwavelength pitch will itself be seriously flawed if evanescent surface waves are not taken into account. This conclusion is, in fact, supported by Fig. 1 of the comment which, in fair agreement with our own finite-difference time-domain results[8,9], shows that the form of the surface wave in the near-zone region cannot be described as a single SPP mode.

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