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Universal shift of the Brewster angle in stratified random media

KWAGN JIN LEE, KIHONG KIM, Division of Energy Systems Research, Ajou University, Suwon, 443-749, Korea — We study theoretically the propagation and the Anderson localization of p-polarized electromagnetic waves incident obliquely on randomly stratified dielectric media with weak uncorrelated Gaussian disorder. Using the invariant imbedding method, we calculate the localization length and the disorder-averaged transmittance in a numerically precise manner. We find that the localization length takes an extremely large maximum value at some critical incident angle, which we call the generalized Brewster angle. The disorder-averaged transmittance also takes a maximum very close to one at the same incident angle. Even in the presence of an arbitrarily weak disorder, the generalized Brewster angle is found to be substantially larger than the ordinary Brewster angle in uniform media. It is a rapidly increasing function of the average dielectric permittivity and approaches 90 degrees when the average relative dielectric permittivity is slightly larger than two. We find that the dependence of the generalized Brewster angle on the average dielectric permittivity is universal in the sense that it is independent of the strength of disorder and the wave frequency. We also make a surprising observation that when the p wave is incident from an optically denser region, the localization length and the average transmittance become larger for stronger disorder in a wide range of incident angle.

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