Abstract Submitted
for the MAR05 Meeting of
The American Physical Society

Delocalization of Light in Random Multilayer Dielectric Media

ALEX SMALL, Department of Physics, UC Santa Barbara, DAVID PINE, Departments of Chemical Engineering and Materials, UC Santa Barbara — Doping random multilayer dielectric media with weak scatterers can cause delocalization of classical waves in cases not considered by previous investigators. Our system consists of parallel slabs of thickness d and refractive index n1, randomly spaced along the z axis and surrounded by a medium of refractive index n2. This system is frequently used to study 1D localization of classical waves. The slabs exhibit Fabry-Perot resonances at frequencies that are integer multiples of $\pi c/n1 d$. We consider the effect of doping this system with small dielectric particles at a low volume fraction. Using scaling arguments we show that above the critical frequency waves undergo a transition from localized evanescent decay to delocalized power law decay. The transition occurs for arbitrarily weak scatterers and low scatterer concentrations, in stark contrast to previous predictions. A rate equation analysis predicts that the wave intensity scales as z^(-3/2). Simulation data will be presented and compared with scaling theory predictions. We also discuss analogies between the delocalization transition and second order phase transitions. The mean angle at which photons exit the sample is analogous to an order parameter. Finally, making analogies to mean field theory, we show that waves can undergo successive delocalization and relocalization transitions.

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Date submitted: 30 Nov 2004 Electronic form version 1.4