# Strong group delay dispersion in 3D photonic band gap crystals and in planar microcavities.

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**Abstract**

We developed an interferometric optical reflectivity microscope to observe the phase sensitive
reflectivity of nanophotonic structures with high spatial and spectral resolution over broad frequency
ranges from 4000 to 13300 per cm, corresponding to wavelengths 750 to 2500 nm. From the frequency resolved phases we obtain the time delay. We study planar microcavities made
from GaAs AlAs, and three-dimensional photonic band gap crystals made from silicon with the woodpile structure. Measurements on planar microcavities have been compared with analytic transfer matrix theory, where an excellent agreement is found. The mean difference between measured and calculated reflectivity is better than 4 percent points. For a planar microcavity with a stopband centred at 1331 nm and a relative bandwidth of 16 percent we observe time delays exceeding 4 ps at the edge of the stopband. For the 3D woodpile structure we observe time delays exceeding 550 fs at the edge of the 3D bandgap. Combined with the very thin metasurface like structure, this yields a lower bound for the group index of larger than 210, much more than previously observed in photonic crystal waveguides. Current studies include developing a model for the 3D woodpile crystal to understand the large group delay.

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