Performance of a Phase Sensitive Photonic Crystal Waveguide Test Bench versus Modulation Frequency

C. M. Reinke, J. D. Huang, S. Yegnanarayanan, and A. Adibi,
Georgia Institute of Technology, Atlanta, GA, U.S.A.

We present measurements of the transmission and group delay properties of photonic crystal waveguides (PCWGs) using a phase sensitive lock-in technique. Using a lock-in amplifier improves the signal-to-noise ratio of the power transmission measurements by at least one order of magnitude, and also correlates features in the group delay spectra (obtained from phase measurements) to the complex transmission properties of the PCWGs. The group delay spectra obtained by the lock-in technique are less sensitive to length-dependent losses than the amplitude transmission spectra, and are therefore a powerful analytic tool for measuring the intrinsic properties of PC structures. This technique also has an advantage as compared to wideband techniques, such as those that utilize ultrafast lasers. In such systems, the large-bandwidth pulses experience distortion at frequencies in the vicinity of the photonic mode gap and slow-light region, whereas the comparably small bandwidth of our system allows for measurements much closer to the slow-light regime before pulse distortion becomes a limiting factor.

The performance of the system is monitored as the modulation frequency of the system is changed. Although large group delays can be measured at lower frequencies, the phase resolution is low. At higher frequencies, the resolution improves significantly but the noise floor is increased due to coherent pickup in the lock-in amplifier. We present a modified test bench that allows for measurements above 20MHz. Detailed performance of this test bench and the roles of different characterization parameters on its performance will be discussed as well.