Slow light propagation through a Moiré grating at the zero dispersion wavelength

T. Maybour, D. H. Smith and P. Horak

The reduction in the group velocity of a light pulse, or 'slow light', has many practical applications including optical switching and buffers. We investigate slow light propagating near the band edge of a Bragg grating. At the Bragg wavelength a resonance occurs in the reflection spectrum creating a photonic band gap. At wavelengths close to the band edge light is transmitted through the grating and a reduction in group velocity is observed, but also an increase in group velocity dispersion (GVD) leading to large pulse broadening preventing any practical use. We present a possible resolution to this problem.

We analyse single period Bragg gratings using coupled mode theory. For a pulse with a given carrier frequency and desired group velocity, there exist two grating periods for a chosen AC grating modulation which produce a band gap above and below the carrier frequency respectively. In both cases, as the group velocity tends to zero the GVD diverges causing substantial pulse broadening. One grating period produces normal and the other anomalous GVD, suggesting that a Moiré grating that superimposes both grating periods could be used to create a zero dispersion wavelength at the carrier frequency. To simulate pulse propagation through such a grating, we employ matrix transfer methods and numerical optimisation to find the grating parameters which produce the smallest group velocity and GVD for a given pulse bandwidth.

Our initial results demonstrate a group velocity reduction by a factor of 4 with negligible pulse broadening. We are currently examining the use of apodisation which will provide an improvement in the grating transmission spectrum and increase the allowable pulse bandwidth. With this we expect to achieve group velocity reduction by a further two orders of magnitude whilst minimising pulse broadening.