EIG에 의한 분산보상의 유연한 통제

Flexibly controlled dispersion compensation by EIG

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Abstract: We propose a dynamic controlling system of dispersion compensation by uisng electromagnetically inudced grating. This has potential applications for active control of dispersion compensation in a broad specteal range of WDM fiber-optic communication channels.

Summary:

We propose a scheme of employing Electromagnetically Induced Gratings (EIGs) for dispersion compensation. [1, 2] Comparing with fiber gratings, it can flexibly control the refractive index modulation and therefore can be used to actively compensate the group velocity dispersion of multiple channels of wave division multiplexed lightwave systems.

A weak probe pulse which is propagating through an optical fiber with temporal dispersion enters into the EIG formed by two counterpropagating control fields. The coherent control fields drive the system with a Rabi frequency Ω_c for the transition of |2>-|3> adibatically, and forms a standing wave grating, $2\Omega_c \cos(k_c z)$, where k_c is the wave vector of coherent field. In the presence of standing waves formed by the coherent control fields, where the frequency of the probe pulse is close to the control fields, we can express the signal field with two slowly varying components $\varepsilon_+(z)$ (propagating forward) and $\varepsilon_-(z)$ (propagating backward):

$$E_p(z,t) = \frac{1}{2}[(\varepsilon_+ e^{ik_p z} + \varepsilon_- e^{-ik_p z})e^{-i\omega_p t} + (\varepsilon_+ e^{-ik_p z} + \varepsilon_- e^{ik_p z})e^{i\omega_p t}]$$

. In interaction picture, the Hamilton is expressed as follows in the Hilbert space spanned by the bare states |1>, |2> and |3> and under the rotational wave approximation:

$$H_I' = -\hbar[g(\varepsilon_+ e^{ik_p z} + \varepsilon_- e^{-ik_p z})|3><1| + 2\Omega_c \cos(k_c z)e^{-i\Delta t}|2><3| + H.c.] \qquad (1)$$

where $2\hbar g$ is the dipole matrix element for the transition of |2>-|1>, L is the length of the medium, k_p and k_c are wave vectors of probe and control field, respectively, and $\Delta = \omega_c - \omega_{32}$ is the frequency detunning of the controlfield. The response of the medium to the field is governed by the desity-matrix equation, which, in the interaction picture, takes the form [3]

$$\frac{\partial \rho}{\partial t} = -\frac{i}{\hbar}[H_I', \rho] + \Lambda\rho \quad (2)$$

where ρ stands for the density-matrix operator, $\Lambda\rho$ summarizes the effects due to the interaction of atoms

The dispersion relation of the scheme is obtained by equantion :

$$q^2 = \delta^2 - \kappa^2, \quad (3)$$

where $\delta = \frac{n_0}{c}(\omega_p - \omega_c)$, $q = k_p - k_c$.

Equation (3) indicates the dispersion relationship is as to that of a uniform Bragg grating, which can be used for pusle compression in transmission.

The most distinct advantage of our scheme is that the grating is formed by two conterpropagating lights and therefore the parameters of the grating is easily varied accoring to the pulse being compressed. It is relatively easy to make the stronger grating than uniform Bragg grating. For example, for a wavelength division multipl WDM system.

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Reference

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