THE OCT APPLICATION IN OPTIC GRADIENT COATING OPTIMIZATION

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The possibilities of multilayered gradient optic coatings (with smooth refractive index variation inside every layer) to produce the photonics effective gadgets – mirrors, filters and in the wide sense optic metamaterials were investigated in [1]. However, conventionally such gadgets were fabricated as multilayer coatings on a glass substrate with the constant refractive index value inside every layer. Moreover, in [2] the optimality of piecewise constant control parameter (refractive index) variation law at such gadgets designing is proved using the optimal control theory (OCT). The question arises: are the advantages of gradient structures the consequences of unjust or incomplete OCT problem statement or the OCT cannot give smooth functions as solutions, for optic coatings at least?

One has to make a reservation consisting in the fact that conventional multilayer interference filters and mirrors have layers' thickness around the wavelength in the layer materials. Whereas in [1] the periodic gradient structures with periods significantly smaller than the light wavelengths passing through them are considered: "Like schemes in microwave domains including elements with dimensions smaller than working wavelengths the nanostructures with subwave dimensions were elaborated to work in the optic range".

It is clear that smooth solutions of the OCT problem may occur only if the control variables enter nonlinearly in the optimal Hamiltonian or the state equations contain the control variables derivatives that move the problem out of the classic OCT. The general field's wave equations containing dielectric and magnetic permittivity's gradients correspond just to the last case but in the equation considered in [1] this gradient is absent. If the coating material is nonmagnetic so that μ=Const, but ε =ε(z)≠Const, in the general wave equation for the electric field in the plane wave approximation the dielectric permittivity gradient is really absent. But for the magnetic field the vector product of this gradient and the field's curl is not zero in the general case and particularly for the plane wave when **H**=**H**(z,t). The equation for the Fourier transform upon time of the magnetic field *y*-component both for TE and TM modes in the case of normal incidence contains the ε(z) logarithm's gradient (a "hatch" means differentiation):

$$H'' - \frac{\varepsilon(z)'}{\varepsilon(z)} H' + \varepsilon(z) \frac{\omega^2}{c^2} H = 0$$

The OCT problem statement on this equation solutions class is considered. At that unlike the classic statement used in [2] the control variable *is not the dielectric permittivity but its gradient*, whereas itself is defined *as the state variable*. As far as this new control variable is all the same linear within the optimal Hamiltonian the solution ε'(z) is piecewise constant coordinate's function so that ε(z) represents the "saw" or periodic trapeze due to the Pontryagin's maximum principle. It means that one has to introduce another auxiliary state variable which derivative – the dielectric permittivity's second derivative – will be the control variable. Now the optimal piecewise constant solution for this control variable will represent the parabola set for "*genuine control*" that is the refractive index as in [1]. Generally, choosing as the control variable the corresponding derivative of the "*genuine*" one can obtain functions of any smoothness degree. However, the presented in this report solutions of primal problems for smooth and piecewise constant refractive index variation laws prove for a while yet the advantages of latter's for spectrum filtration except for apodizing filters. The question about the artificially made dispersion will be considered elsewhere.

REFERENCES

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