SUPERIMPOSED LONG PERIOD GRATINGS OBTAINED BY DISCRETIZED SINUSOIDAL REFRACTIVE INDEX PATTERN

Cosimo Trono[1*], Federico Valeri[1,2], Francesco Baldini[1]

1 Istituto di Fisica Applicata "Nello Carrara", Consiglio Nazionale delle Ricerche, 50019 Sesto Fiorentino, Italy
2 Dipartimento di Fisica, Università degli Studi di Firenze, 50019 Sesto Fiorentino, Italy
**c.trono@ifac.cnr.it*

A novel technique for the inscription of superimposed long period gratings with arbitrary grating pitches, based on the discretization of an ideal continuous sinusoidal refractive index pattern is proposed and experimentally validated.
Keywords: superimposed LPGs.

1. Introduction

A novel technique for the inscription of superimposed long period gratings with arbitrary grating pitches is proposed [1]. The technique is based on the discretization of a continuous sinusoidal refractive index pattern with a step function (Fig. 1). The refractive index variation is induced by means of the irradiation of a photosensitive fiber with a 248 nm UV laser beam. Two superimposed LPGs (DLPG) with different grating pitches have been realized with the discretization technique and the transmission spectrum was compared with the one of two superimposed LPGs obtained with the traditional square wave refractive index modulation (SQLPG).

2. Results

The practical realization of superimposed LPGs with different grating pitch Λ by using the point by point technique and the excimer laser has some drawbacks related to the non-linear relation between the core induced refractive index change δn_{co} and the UV fluence F in the irradiated fiber section, expressed by the following non-linear power function [2]:

$$\delta n_{co} = aF^B \quad (1)$$

This implies that the sequential inscription of two gratings characterized by a different Λ, gives rise to poor spectral characteristics because the total induced RI change in the fiber sections, where the fluence F_1 and F_2 cumulate, is less than the sum of the changes separately induced by F_1 and F_2.
If we introduce the design wavelength $\lambda_{D,l}$ as the resonance wavelength of the $LP_{0,l}$ cladding mode for an infinitely weak grating, the LPG resonance wavelength will follow the trend expressed by the following equation:

$$\lambda_{res,l} = \lambda_{D,l} + \Lambda A_l F^B \quad (2)$$

Where A_l is a coefficient which depends on the $LP_{0,l}$ cladding mode. The parameters of eq. (2) were estimated by the measurement of the λ_{res} during the inscription of the SQLPG, and the fluence per step necessary for the obtainment of the ideal sinusoidal pattern was calculated from the inversion of eq. (2). For the validation of the proposed technique, the superimposed SQLPG and DLPG writing techniques were compared. In the case of the superimposed SQLPGs, worsening of the transmission characteristics was observed with respect to the two single SQLPGs written into two separate fibers, whereas the preservation of the spectral characteristics of the single separated DLPGs was observed for the superimposed DLPGs.
The proposed DLPG can have applications in fundamental physics, for example in the optical analogue of stimulated Raman adiabatic passage [3], and in telecommunications, for the bi-directional conversion of several fiber modes in single mode, as well as in the sensing field, for example in a compact device for the simultaneous multi-parameter sensing.

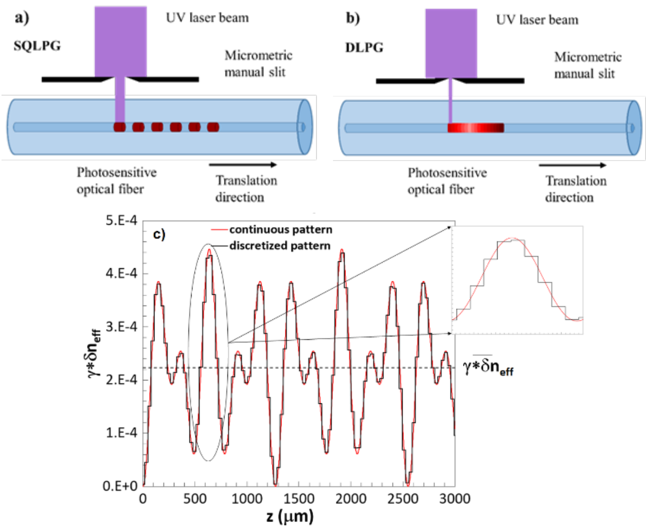

Fig. 1 a) Standard LPG, square wave RI modulation (SQLPG). b) Discretized sinusoidal RI modulation (DLPG). c) In red: the ideal continuous δn pattern; in black: discretization of the continuous δn pattern.

References

1. Trono, C., Valeri, F. & Baldini, F. *Opt. Lett.* **45**, 4, 807 (2020).
2. Anderson, D.Z., Mizrahi, V., Erdogan, T., White, A. E. *El. Lett.* **29**, 6 (1993).
3. Thyagarajan, K., Gupta, R. *J. Mod. Opt.* **63**, 1331 (2016).