Spatial characterization of fiber Bragg gratings by Optical Space Domain Reflectometry (OSDR) applying local IR- or UV-light pertubations

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Abstract: OSDR-techniques based on local phase pertubation induced by IR- or UV-laser radiation are used for spatial characterization of fiber Bragg gratings. Experimental results are in good agreement with those obtained by the side-diffraction technique. Both techniques are compared with respect to simplicity of the setup and the yield of information.

Fiber Bragg gratings (FBGs) are widely used for telecommunication and sensor systems. In some cases it is important to know the axial distribution of the grating parameters as well as the exact grating location in the fiber. The most common and simplest way of the grating characterization is measuring its transmission/reflection spectrum. This method determines only the integral characteristics of the FBG. To obtain the spatial distribution of local grating properties other techniques such as OLCR [1], side-diffraction [2], heat-scan [3] can be used.
An optical space domain reflectometry (OSDR) method for obtaining the spatial variation of the complex coupling coefficient $\kappa(z)$ of FBG with high spatial resolution (about 100 μm) has been proposed in [4]. There, a fiber was covered by an absorbing coating and locally heated by a HeNe laser beam. In the present work we suggest application of more suitable laser sources (a CO-laser and a frequency-doubled Ar-ion laser) for local induction of a phase perturbation in the OSDR technique without a need of an absorbing coating with its limited homogeneity.
The OSDR technique for spatial characterization of grating properties is described in [4]. It is based on introducing a local AC phase perturbation scanned along the grating and measuring the transmission/reflection variations at a fixed wavelength outside the stop band. In our present experiments we used a similar setup with either a frequency-doubled Ar-ion laser (λ = 244 nm) or a CO-laser ($\lambda \approx$ 5 μm) instead of a He-Ne laser. The penetration depth of CO-laser radiation into silica glass is 100-200 μm which allows us to heat the fiber cross-section with good uniformity. The UV-light of the Ar-ion laser induces a transient optical phase perturbation directly in the fiber core [5]. In both cases no additional absorbing coating is required and the spatial resolution and uniformity of phase changes are improved. In addition these radiation types can induce a rather large phase which increases the sensitivity of the method.

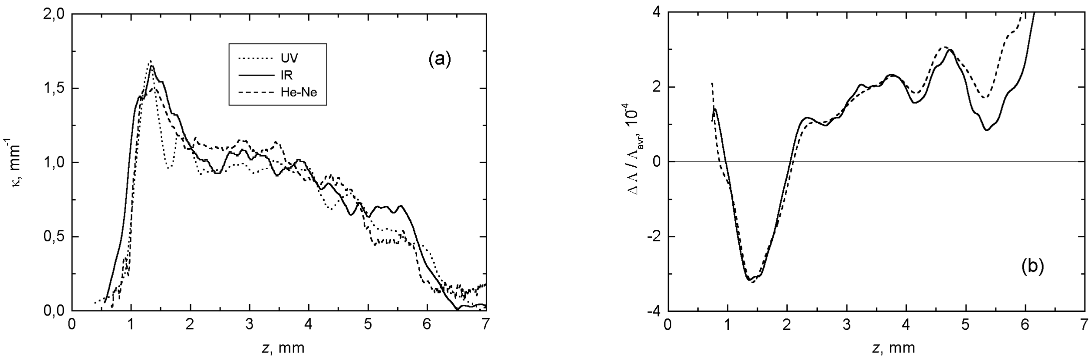

Fig.1. Calculated distributions of index modulation amplitude measured by UV- and IR-OSDR techniques as well as by side-diffraction technique(a); relative period distribution for two different IR measurements (b).

Comparison of obtained Δn_{mod} distributions with that measured by the side-diffraction technique showed good coincidence within 10-15% deviation. Grating phase information provided by the OSDR technique allowed us to achieve satisfactory agreement between calculated and measured grating spectra.

References

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