FORCED-RAMAN-SCATTERING-BASED AMPLIFICATION OF LIGHT IN ONE-MODE QUARTZ FIBERS

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S u m m a r y

The fundamental research successes of stimulated Raman scattering (SRS) of light in the single-mode fibers have resulted not only in the occurrence of a new laser physics trend and photon-phonon interaction applications to the optical wave amplification, but in the appearance of some problems which cannot be solved by traditional methods of the electronic amplification theory without taking the optical nonlinearity of SRS into account. Here, we give a systematized review of theoretical and experimental achievements in the field of the Raman amplification of optical radiation, by basing on the theoretical positions of nonlinear optical processes and the Raman spectroscopy basic researches.

The brief preliminary sketch of the 80-year research and development history of the Raman spectroscopy methodology outlines the main stages of the fiber Raman amplifier (FRA) creation. We consider the experimental preconditions, general classification of optical amplifiers, their role in the mastering of transparency windows of silica fibers, and the main problems of the usage of FRAs. The well-known deduction of the basic relations in both semiclassical and quantum approaches to SRS in fibers at the theory statement is replaced with a more profound physical analysis of initial approximations and their consequences; properties of the photon-phonon nonlinearity of the lowest orders and its creation mechanisms are compared; and the amplification threshold conditions are given. We survey the applicability of laser sources in FRA pumping units with the use of semiconductor laser diodes and fiber lasers satisfying the requirements of nonlinear optics, the ways of suppression of noise intensity fluctuations; partial coherence influence; and the amplifier multiwave pumping. Spectroscopic modeling methods of Raman amplification are considered not only as an addition to direct calculations based on the coupled equations, but also as independent methods of a quantitative rating of the important parameters of optical gain. The stated simplified method of an actual band and the multiwave decomposition of the amplification spectrum give a practically exact approximation to the Raman gain profile in widespread fibers. The quantitative definition technique of the full transparency conditions for fibers and the amplification bands is presented. The prospect rating of FRA development is given in summary.