Waveform distortion of the stimulated Brillouin scattering in a single mode optical fiber with Q-switched Nd:YAG laser

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Abstract : We observe the distortion of the back scattered Stokes pulse and the complementary distortion of the transmitted pulse by the stimulated Brillouin scattering when a Q-switched Nd:YAG laser pulse injected into a single mode optical fiber. We determine the constant required energy for the SBS by comparing their temporal shapes.

1. Introduction

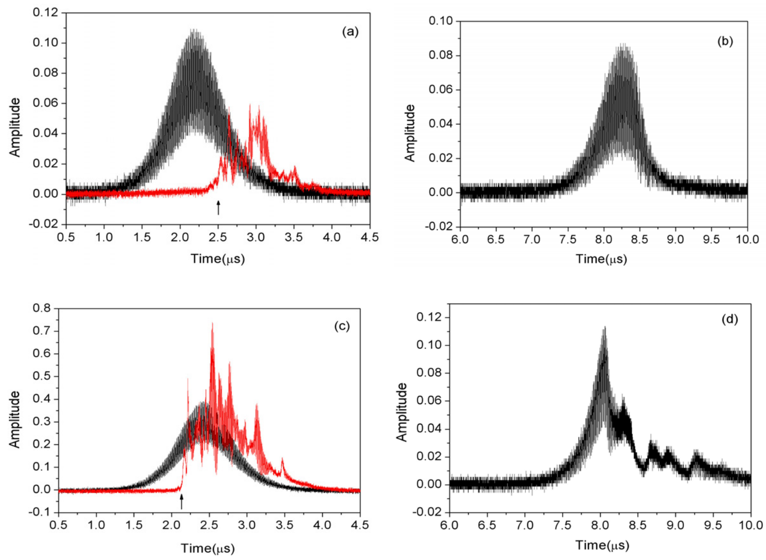
Many scientists have studied the transient effect of the stimulated Brillouin scattering (SBS) in a fiber because of the interest of nonlinear effects as well as of the importance of the effective telecommunication[1,2]. When a cw laser is injected into an optical fiber the back scattered Stokes waves (or SBS) are composed of many short bursts with chaos[3,4]. When a short pulse (~10 ns duration) is used, the SBS waveform is distorted especially on the rising edge. From the simultaneous pulse curves of the input and the SBS, the threshold energy for the SBS could be calculated[5]. Our purpose of the study is to determine the threshold energy of the SBS in a single mode optical fiber when a pulse of laser with ~1μs duration is used.

2. Experiment

In the experiment we obtain ~760ns duration laser pulse by Q-switching from cw Nd:YAG laser. A Q-switched laser pulse train, which repetition rate is 100Hz, is obtained by inserting an acousto-optic Q-switcher in cw Nd:YAG laser cavity. The used fiber is a standard-telecom-grade single mode optical fiber with length of ~1.2km. Both the entrance and exit face of the fiber are polished with an angle of ~82^o to prevent feedback. The estimated reflectivity is <10^{-8} %. To maximize optical coupling with the fiber, the direction of the fiber is inclined, not parallel, to the incident laser beam by ~ 4^o. For the effective launching of the input pulse into an optical fiber, the beam width of laser output is expanded twice using two lenses, whose focal lengths are 5cm and 10cm, each. The expanded laser beam is launched into the optical fiber through a 10x microscope lens. The input power is controlled with a half wave plate and a polarizer before the input facet of the fiber.

3. Results and Conclusion

We inject ~760ns duration pulse of the Nd:YAG laser with 100Hz into the fiber in the absence of feedback. From the experiment of the SBS near the threshold, we observe the back scattered Stokes pulse which is severely distorted. And it seems that it is composed of several short bursts on the long Gaussian pulse like Fig.1(a) and (c). With the increase of the input power, we can observe that the beginning point of the SBS comes up close to the head of the input pulse(the left movement of the arrow in Fig.1). The distortion of the transmitted pulse seems to be complementary with the back scattered Stokes as we expected(Fig.1(b), (d)). From these results we can determine the necessary energy to start the SBS in a single mode optical fiber.



"Fig.1. Temporal shape of the SBS(red) for the input(dark) of (a) 47μJ, (c)220μJ. The arrow in the graph is start-point of the SBS. (b) and (d) are the transmitted pulse of (a) and (c) respectively."

4. References

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