Abstract

It is found that low frequency noise is always as a fast, easy-to-use, accurate and non-destructive tool to characterize the performance and reliability of materials and electrical devices. In this paper, $1/f$ noise model in 980 nm InGaAs/GaAs laser diodes under low injection current is presented. As shown in Fig. 1a), the noise equivalent circuit model of laser diodes with parasitic parameters which includes the parameters of package part, laser chip part and the active region part of LD is developed. The typical electrical noise spectrum of a LD sample at different low injection currents is shown in Fig. 1b). According to the noise theory (mainly the mobility fluctuation model, the carrier number fluctuation model), the recombination $1/f$ noise model based on the parasitic parameters in the package surface and active region of LD under low injection current will be described. It is suggested that the accumulation of the interface states and oxide-charges and the fluctuations of surface non-radiative recombination current and the package terminal resistance cause the $1/f$ noise. But the surface non-radiative recombination current dominates when the LD operates under low injection current. The fluctuation of the diffusion current due to the interface traps leads to the diffusion $1/f$ noise in the active region of the laser diode. The fluctuation of the laser chip contact resistance also causes the $1/f$ noise.

Fig 1. a) The noise equivalent circuit model of the LDs based on parasitic parameters; b) Typical electrical $1/f$ noise spectrum of the LD sample at different currents and forward current-voltage characteristics (in the insert).