Low frequency noise in double heterostructure P-InAsSbP/n-InAs mid-IR photodiodes at cryogenic temperature: Photovoltaic mode and forward bias

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Low frequency photocurrent noise, as well as the forward current noise are studied for the first time in midinfrared InAsSbP/InAs double heterostructure photodiodes at 100 K. Two types of photodiodes are identified. For the first type, the spectral noise density, S_I, depends on frequency as $1/f^{\gamma}$. For the second type, generationrecombination (GR) noise component dominates. Our results show that in those samples, it is one and the same local center that is responsible for the noise over the entire photocurrent range. The forward current noise in all samples is lower than that previously observed in InAsSbP/InAs single heterostructure photodiodes at 77 K. In samples demonstrating $1/f^{\gamma}$ noise, the spectral noise density, S_I, is proportional to the square of the current. In samples with GR noise, we also observe $S_I \sim I^2$ dependences in a certain current range. At higher currents, the noise decreases or tends to saturate. We show that at 100 K, the Nyquist noise is dominant and can be used for estimating the specific detectivity at photocurrents $I_{ph} \leq 5 \cdot 10^{-9}$ A for samples showing $1/f^{\gamma}$. noise, and at $I_{ph} \leq 2 \cdot 10^{-9}$ A for samples presenting GR noise component. At higher I_{ph} the photocurrent noise should be also taken into account.