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Optically tunable transducers based on nanowire transistors for ultrasensitive detection of small biological signals

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Abstract

The development of transducers for biosensing applications attracts the increasing attention of the scientific community due to the great potential to find new parameters for ultra-high sensitive reliable detection of small biological signals. We fabricated high-quality liquid-gated nanowire (NW) field-effect transistors (FETs) and studied their transport and noise properties in different operation regimes in an $MgCl_2$ solution in the dark and under IR optical excitation. Surprisingly, the high photosensitivity of two-level fluctuation (TLF) parameters registered as a result of single trap phenomena to infrared radiation was revealed. Moreover, it is demonstrated that the parameters of TLF can be effectively tuned by optical excitation. These results represent a new approach for the optimization of characteristic times: capture and emission times to obtain enhanced bio-sensitivity in liquid-gated NW FET devices. The method is associated with dynamic fluctuations reflecting single-trap phenomena precisely analyzed using a histogram approach. New characteristic times for biosensing applications and their dependence on the potential of the dielectric surface as well as on optical excitation are analyzed. It is found that the parameters can be fine-tuned without changing external voltages. It was demonstrated that the sensitivity of FET biosensors can be amplified by 1.5 times under light excitation compared to the amplification coefficient obtained in the dark. The amplification model is suggested and discussed. The obtained results are promising for the integration of such transducers in digital signal analyzing systems for more precise treatment of small biological signals.