Field-Effect-Induced Current Fluctuation in Patterned Self-Doped Polyaniline

Osaka Univ., ○Jiannan Bao, Yoichi Otsuka, Yuki Usami, Takuya Matsumoto

E-mail: baoj17@chem.sci.osaka-u.ac.jp

Noise plays a significant role in biological information processing system, including human brain. An example of the utility of noise is based on a phenomenon, stochastic resonance (SR), where a weak signal can be boosted to assure the signal transfer by adding white noise. Several groups have reported the detection of stochastic resonance (SR) in molecular devices. In these works, noise was generated by an external function generator or carbon-nanotube-based materials. To realize SR in molecular devices, it is necessary to develop methods for fabricating molecular noise generators that have a high degree of freedom for device integration. Furthermore, for the development of reservoir computing devices, multiple-noise generators capable of producing different types of noise are essential, and current material-based noise generators do not satisfy this requirement.

Fig. 1 shows the schematic overview of device fabrication and electrical measurement. Au/Cr electrodes are fabricated by thermal evaporation on SiO_2/Si substrate. SPAN lines were drawn between the gold electrodes by nanopipette using SPAN solutions. The width, length and thickness of the SPAN patterns are 3~6 μm, 500 μm and 100 nm, respectively. Electrical current was measured by a source meter using a high-vacuum prober in a temperature range of 6 K to 300 K and 10^{-4} Pa vacuum level. Laser irradiation was applied using a tunable 532 nm laser source.

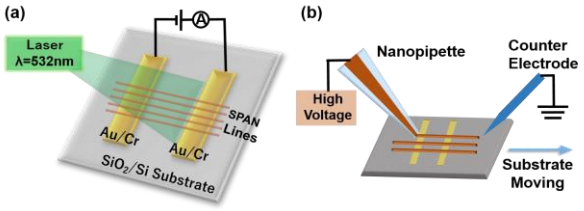

Fig. 1 (a) Schematic illustration of electrical measurement and (b) patterning of SPAN using nanopipette

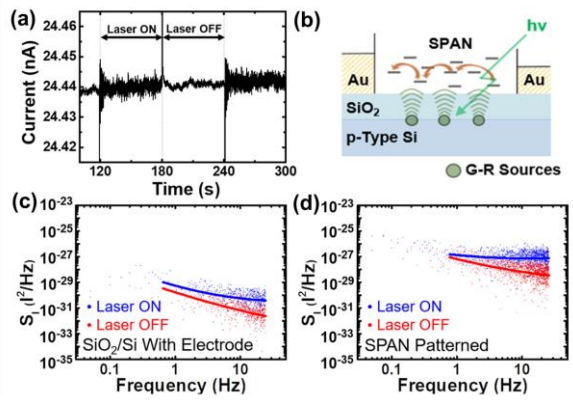

Fig. 2 (a) I-t characteristics with 60s laser pulse; (b) possible noise amplification mechanism; PSD for sample before (c) and after (d) SPAN patterned, respectively.

As shown in Fig. 2(a), the I-t characteristics under 1V displayed noise upon laser irradiation. The PSD spectrum of sample before/after SPAN patterning were shown in Fig. 2(c) and 2(d), respectively. For SPAN patterned sample, a white noise-like shape PSD spectrum was obtained in the frequency range of 1~25 Hz. As shown in Fig. 2(b), the separation of photoinduced carrier at SiO_2/Si interface creates fluctuated electrical field, which affects the carrier mobility in SPAN molecules, result in the fluctuation in current. Recently we are working on multiple noise generator system and silicon nanoparticle-SPAN composite-based noise generators. The details will be addressed at the presentation.

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