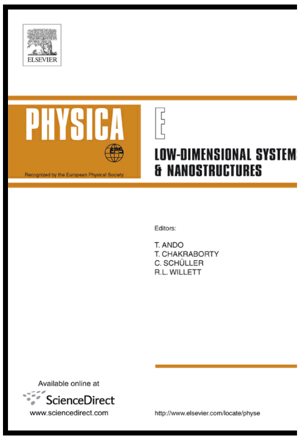

A Seamless-Pitched Graphene Nanoribbon Field Effect Transistor

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A Seamless-Pitched Graphene Nanoribbon Field

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Effect Transistor

***Abstract*-This paper proposes a graphene nanoribbon field effect transistor (GNRFET) consisting of pitched semiconducting GNRs as the channels that are connected to the metallic graphene source/drain in a seamless fashion. We obtained the diagrams for frequency bandwidths, step time responses, and Nyquist stability for the seamless pitched GNRFET (SP-GNRFET) with a channel having 100 pitched GNRs at 10 nm pitch in the common source configuration with various dimensions of the GNRs. The aforementioned diagrams were also obtained for the pitched carbon nanotube field effect transistor (CNTFET)with a channel having 100 pitched CNTs at 10 nm pitch in the common source configuration with various dimensions of the CNTs. In order to compare the SP-GNRFET and the pitched CNTFET, physical parameters of the GNRs/CNTs were assumed to be the same in both devices. The results show that when the dimensions of GNRsin the SP-GNRFET increase, the frequency bandwidth decreases, but relaxation time and Nyquist stability increase. Moreover, with an increase in the dimensions of CNTs, similar behavior is observed for the pitched CNTFET.**

The results also show that the frequency bandwidth of SP-GNRFET is in the range of 10 THz and is more than that of the pitched CNTFET by two orders of magnitude. This is achieved by eliminating the Schottky barrier between the channels and source/drain contacts in the SP-GNRFET. Nevertheless, step time responses for the SP-GNRFET show multi-harmonic oscillations like those for the pitched CNTFET. This shows the importance of stability analysis as a challengeto the SP-GNRFET. Nyquist diagrams predict lower stability for SP-GNRFETs than for pitched CNTFETs. This is because elimination of the Schottky barrier results in a reduction in the overall impedance of the SP-GNRFET, which in turn leads to the frequency of the fluctuations in the SP-GNRFET being more than that in the pitched CNTFET.

***IndexTerms* Seamless pitched GNRFET(SP-GNRFET), pitched CNTFET, Schottky barrier, Frequency bandwidth, Step time response, Nyquist diagrams.**

I. BACKGROUND

When graphene,which is a single stable sheet of graphite, was synthesized, it was proposed as a new candidate material for the next generation of electronic devices[1]. Graphene is a two-dimensional material with a zero-band energy gap [2]. However, its narrow stripes, which are known as graphene nanoribbons (GNRs) and are less than 100 nm wide, are quasi-one-dimensional materials with finite energy gaps [3]. Because of their excellent electrical and mechanical properties and their ease of orientation during synthesis, GNRs have shown their potential as an important material in electronic applications, especially as the channel for transistors [4-8]. In recent years, there have been reports of the fabrication of a 100-GHz transistor from wafer-scale epitaxial graphene [9] and a high-mobility GNR field effect transistor (GNRFET) operating at a low voltage at room temperature [10]. Moreover, [11] analytically investigated the frequency response of a GNRFET with an array of GNRs and reported a frequency bandwidth of about 1 THZ. Also, some studies have attempted to increase the speed of GNRFETs through the use of doped source/drain (S/D) contacts [12] and appropriate substrate materials such as boron-nitride dielectrics [13] and have observed a frequency bandwidth of about 1-5.8 THZ. In most of these studies, there is a Schottky barrier between the semiconducting GNR channel and the metallic S/D contacts, and this barrierlimits the frequency bandwidth of GNRFETs.

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