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Effect of Channel Length Variation on the Electrical Conductivity of Passivated Back-Gated Graphene Field-Effect Transistor (GFET) Using Silvaco TCAD Tools

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Abstract

This paper presents the simulation study of passivated backgated graphene field-effect transistors (GFETs) with different channel lengths using Victory Device tool by Silvaco TCAD. The passivated backgated GFETs were designed for radiation device applications. Six GFETs models with channel lengths ranging from 0.1 μm to 10 μm were analyzed to investigate the influence of variation in channel length on the conductivity of GFET. Nearly all devices with shorter channel lengths exhibit ambipolar characteristics with V-shaped curves, indicating the conductivity of holes and electrons at different bias conditions. Interestingly, GFETs with longer channels, specifically 3 μm , 5 μm , and 10 μm , exhibited unexpected W-shaped transfer characteristic curves, featuring multiple charge neutrality points (CNPs). This behavior is attributed to the non-uniform doping induced by charge interactions between the channel and the passivation layer. The central region of the channel may experience a higher doping effect due to impurity diffusion from the passivation material compared to the region near to the metal electrodes. However, the W-shaped curves of longer channel GFETs become less prominent when compared to smaller channel length devices. This suggests that high conductivity in shorter channel GFETs dominates the overall transfer curve performance. The analysis of output characteristics (ID–

VD) at $V_G = 10\text{ V}$ further supports the influence of channel length on device performance, with the shortest channel length ($0.1\text{ }\mu\text{m}$) recording the highest saturation current (ISAT), followed closely by $0.6\text{ }\mu\text{m}$, aligning with its strong ambipolar transfer characteristics. These findings highlight the importance of channel scaling in designing stable and reliable backgated GFETs for radiation applications. © 2026 Trans Tech Publications Ltd, All Rights Reserved.

Author keywords

channel length; GFET; graphene; simulation; TCAD silvaco; victory device

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Abstract

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