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Self-catalyzed growth of InAs nanowires on graphite for flexible optoelectronic device applications

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The advent^{1, 2} of the two-dimensional (2D) graphene, has sparked enormous research interest owing to its extraordinary electronic and optical properties including ultra-high carrier mobility^{3, 4}, exceptionally high thermal conductivity, flexibility and high optical transparency^{5, 6} which offers huge potential for applications in transparent, stretchable and flexible electronics. The monolithic integration of semiconductor nanowire (NWs) on graphene/graphitic substrates (GS) has stimulated enormous research interest over the recent years as it would enable the exploitation of the exceptional qualities of the former with the intriguing properties of the latter and provide a unique platform for the development of high performance, sophisticated, flexible and cost-effective optoelectronic nanodevices. The growth of InAs nanowires on graphite holds enormous promise for the development of flexible and functional hybrid devices such as solar cells and light emitting diodes. InAs NWs were grown on GS by solid-source MBE. Mechanically exfoliated graphite films from highly oriented pyrolytic graphite (HOPG) were transferred onto Si (111) substrates and subsequently loaded into the system and thermally outgassed. Indium (In) droplets were pre-deposited on the films prior to growth initiation at pre-optimised conditions. The InAs NWs were then grown at a temperature of 450°C to 500°C by the spontaneous opening of In and As for NWs growth. The surface morphology of the NWs was investigated using a FEI XL30 SFEG scanning electron microscope (SEM) while Transmission electron microscope (TEM) images were taken with a JEOL-JEM 2100 microscope working at 200 kV. Figure 1a shows the 45° tilted SEM image of InAs NWs grown on graphite while the selective area electron diffraction pattern and typical HRTEM image of as-grown NWs are shown in Figures b and c respectively. The nanowires are vertically well aligned with no observable tapering. Compared to InAs NWs grown on Silicon, it will be shown that the NWs presents a relatively low density of defects. InAs-NWs/graphite heterojunction devices exhibiting rectifying behaviour was observed. A Room temperature photovoltaic response with a cut-off wavelength of 3.4 μm was realized. This unravels a promising technique for the monolithic integration of InAs NWs with graphite for applications in flexible Infrared Optoelectronic Devices.

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