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Centimeter scale pattern growth of graphene films for stretchable transparent electrodes

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Large scale pattern growth of graphene is one of the most awaiting problems to be solved in order to bring this material for device application. Recently, macroscopic scale graphene films have been prepared by two-dimensional assembly of graphene sheets chemically derived from graphite crystals and graphene oxides. However, the sheet resistance of these films is found to be much larger than theoretically expected values. Here, we report the direct synthesis of centimeter-scale graphene films using chemical vapor deposition (CVD) on thin Ni layers, where the overall structures are connected by lateral electric connections. As a result, the transferred graphene films show very low sheet resistance with excellent optical transparency. At low temperatures, the single layers transferred on SiO_2 substrates show high electron mobility with the signature of quantum Hall effect, implying that the quality of CVD-grown graphene is as high as mechanically cleaved graphenes. Employing these outstanding mechanical properties of graphenes, we also demonstrate the macroscopic usage of the highly conducting and transparent electrodes for flexible/stretchable/foldable electronics.