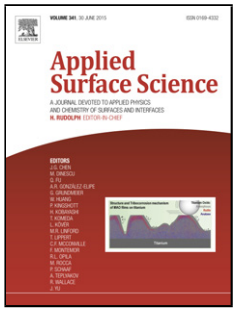

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Facile synthesis of differently shaped, ultrathin, and aligned graphene flakes without a catalyst for highly efficient field emission

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Abstract

Aligned graphene flakes (AGFs) were prepared on different substrates without a catalyst by using radio frequency (rf) sputtering deposition. Their shapes can be readily controlled by adjusting substrate temperatures and rf powers. Ultrathin AGFs (less than 5 layers) can only be prepared with substrate temperatures higher than 1000 K, and AGFs grown at 1100 K are wrinkled graphenes. The rf power controls the AGF shapes by means of hydrogen plasma etching, and the growth rate of AGFs decreases with the increase of rf powers. The catalyst-free growth characteristic determines that the growth of AGFs is substrate independent, but their ultimate shapes greatly depend on the geometric configuration and surface topography of substrates due to the defect-guided nucleation of AGFs. The field emission properties of differently shaped AGFs and AGF composites were measured. Optimal field emission properties are obtained from AGF–Si nanowire composites. They have an ultralow turn-on electric field of 1.80 V/μm, which for the as-grown Si nanowires is 7.33 V/μm, and also have excellent field emission stability after being perfectly aged. We consider that both the nanosharp edges of AGFs and the high aspect ratios of Si nanowires are responsible for this excellent field emission performance.

Keywords: graphene; radio frequency; catalyst-free; composites; field emission; defect