Growth of graphene nanoislands on a Ni(111) surface

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Abstract:

Since they first time a layer of graphene was isolated in 2004 [1], the interest in this material increased exponentially. The main attraction of this material lies in their unusual and surprising electronic, mechanical and magnetic properties such as the anomalous quantum Hall effect, the absence of electronic localization, high optical transparency, the high electrical conductivity, flexibility and high mechanical strength. These properties make graphene a very promising material for applications in electronics and spintronics, and therefore it is necessary to control the growth and properties at the nanoscale.

The growth of graphene layers on the nickel surface by decomposition of hydrocarbons is interesting for three main reasons. On the one hand, the lattice constant of the surface of Ni(111) coincides almost perfectly with the lattice constant of graphene, which allows it to grow in a (1×1) structure. Moreover, due to the catalytic effect of nickel surface, it is an autoterminated reaction, i.e., the reaction stops once the graphene monolayer is formed avoiding the growth of multilayers [2]. Finally, the Nickel is a ferromagnetic material, which opens the door to applications in spintronics.

Progress in the manufacture of low dimensional structures such as graphene nanoribbons has been reported [3]. It shows that the electronic properties of graphene change in a non-trivial way going to nanoscopic dimensions mainly due to the contribution of edge effects.

In this work we study by STM the growth of graphene on a Ni (111) surface by decomposition of hydrocarbons [4]. By varying parameters such as the dosage of hydrocarbon, reaction time and temperature was possible to obtain in a reproducible manner a wide range of coverages. For low coverages the carbon atoms organize themselves into graphene nanoislands whose size and density are related to the reaction parameters. These nanoislands, initially with irregular shapes, may, by further thermal treatment selectively acquire a triangular (Fig. 1) or hexagonal shape both with zig-zag edges. In the case of triangular islands all edges have the same packaging with the nickel surface

underneath while in the case of hexagonal islands edges change alternatively the packaging. The optimum conditions to obtain nanoislands of particular size and shape are studied by systematic variation of the parameters of the hydrocarbon decomposition reaction and the thermal diffusion of carbon on the surface.

Bibliography:

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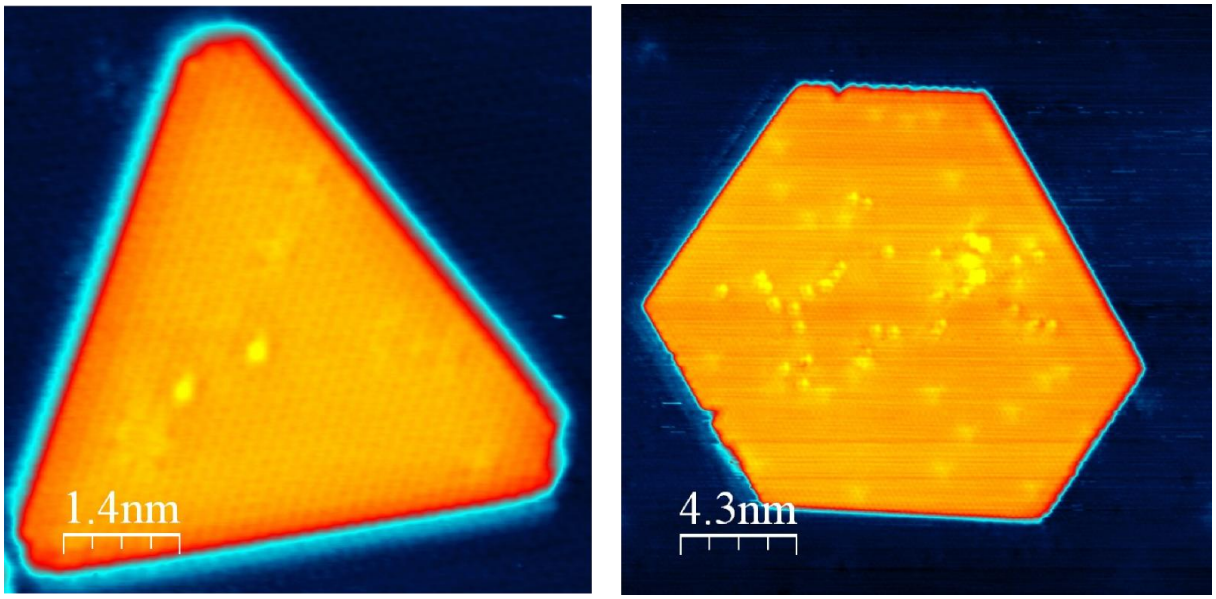

Figure 1: STM images of triangular and hexagonal graphene nanoisland on a Ni(111) surface.