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Research Article

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Kinetics of defect formation in chemically vapor deposited (CVD) graphene during laser irradiation: The case of Raman investigation

Giampiero Amato[1], Gianluca Milano[2], Umberto Vignolo[2], and Ettore Vittone[2] (✉)

[1] Quantum Research Laboratory, INRIM, Strada delle Cacce 91, Torino, Italy
[2] Department of Physics, NIS Research Center, University of Torino, via Pietro Giuria 1, 10125 Torino, Italy

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ABSTRACT

The effect of laser irradiation on chemically vapor deposited (CVD) graphene was studied by analyzing the temporal evolution of Raman spectra acquired under various illumination conditions. The spectra showed that the normalized intensity of the defect-related peak increases with the square root of the exposure time and varies almost linearly with the laser power density. Furthermore, the hardness of graphene to radiation damage depends on its intrinsic structural quality. The results suggest that, contrary to the common belief, micro-Raman spectroscopy cannot be considered a noninvasive tool for the characterization of graphene. The experimental observations are compatible with a model that we derived from the interpretative approach of the Staebler–Wronski effect in hydrogenated amorphous silicon; this approach assumes that the recombination of photoexcited carriers induces the breaking of weak C–C bonds.

1 Introduction

Metastability of thin films grown either by physical or chemical vapor deposition has been extensively studied in the last few decades as one of the several phenomena occurring in numerous materials. These phenomena include heating-induced structural changes, e.g., agglomeration [1], or the creation of additional defects under electrical or optical stimulation [2].

Rather than an absolute and isolated minimum of the total potential energy, a phenomenological description of this class of systems considers the configurational ground state to be a relatively flexible arrangement of the atoms. This arrangement allows various local minima of potential energy separated by a relatively continuous distribution of barriers. Consider two configurational energy minima with an energy difference of ΔE, separated by a barrier of height V_0. If the externally applied excitation $E_{ex} \geqslant \Delta E + V_0$, stimulated transitions between the two configurational states become possible. Furthermore, if the barrier is thin enough, spontaneous transitions between the minima can occur via tunneling. One class of phenomena, which occurs in both crystalline

Address correspondence to vittone@to.infn.it