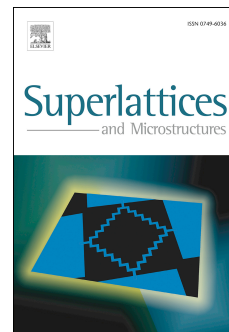


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1 Raman spectra investigation of the defects of chemical vapor 2 deposited multilayer graphene and modified by oxygen 3 plasma treatment

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14 Abstract

15 Graphene, a two dimensional material, can be modified its properties by defects engineering.
16 Here, we present Raman spectra studies of the multilayer graphene (MLG) fabricated by
17 low-pressure chemical vapor deposition over copper foil, and report that the defects of MLG
18 can be controlled by adjusting methane concentration. Moreover, MLG can be changed from
19 metallic to semiconducting properties by using oxygen plasma treatment, and we
20 investigate the defects evolution of the graphene after exposing to oxygen plasma by Raman
21 spectra. Our results indicate that the amount of defects in graphene can be changed by
22 regulating the methane concentration and oxygen plasma exposure times, but the primary type
23 of defect in MLG is still boundary-like defect. It is valuable for understanding the physics of
24 defects evolution through artificially generated defects, and such defect engineering will
25 greatly open up the future application of the novel material.

26 **Keywords:** graphene, defect, Raman spectra, oxygen-plasma

27 1. Introduction

28 Since being exfoliated from graphite, graphene has triggered scientific
29 community's enthusiasm due to its outstanding properties. Graphene consists only one
30 monolayer of carbon atoms arranged in a honeycomb lattice [1]. Ideal graphene
31 possesses unique mechanical, thermal, optical and electrical properties, but it shows
32 metallic or semimetallic behavior with a bandgap of zero or close to zero. Introducing
33 defects can tailor the properties of graphene so that the graphene is promising to be
34 applied in next-generation transistors, nanosensors and other applications [2-5]. There
35 are some methods such as electron or ion irradiation, reaction with oxygen by heating
36 in oxygen atmosphere or treating by oxygen plasma [6-9] can be adopted, e.g., the
37 graphene can become p-doped behavior after treated by oxygen plasma as the defects
38 introduced and the carbonyl bonds (C=O, C-O-C) formed [10, 11]. Previous reports

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