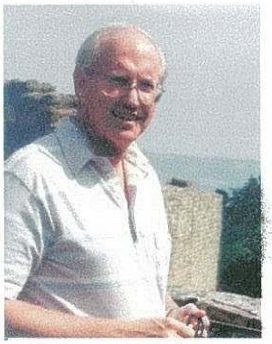

千葉大学創立６０周年記念事業

60th Chiba University

平成２１年度　第１回量子機能デバイス講演会
2009 The 1st Quantum Nano Devices Seminar

日　　時：平成 21 年 7 月 1 日(水)　午後４時より

場　　所：千葉大学西千葉キャンパス，自然科学総合研究棟 2 号館，2F 会議室

講演題目：**Room Temperature Velocity Saturation in Intrinsic Graphene**

講　　師：アリゾナ州立大学，David K. Ferry 教授

協　　賛：日本物理学会，応用物理学会，グローバルＣＯＥ「有機エレクトロニクス高度化スクール」

講演内容：

Recently two-dimensional graphene has generated intense research interest[1], especially after the fabrication of the first field-effect graphene based device[2]. However, apparently there have been no reports of high electric field behavior in bulk graphene to date. Here, we report ensemble Monte Carlo (EMC) studies of velocity saturation in intrinsic graphene at room temperature (Fig. 1). The parameters for the phonon scatterings were obtained from fitting experimental data[3] of graphene sheets in a variety of dielectric media, in which mobilities as high as 44,000 cm^2/Vs were observed at 300 K. In our work, velocity saturation was clearly observed at low carrier density ($\leq 5\times10^{12}$ cm^{-2}). Saturation velocity as high as 2.7×10^7 cm/s was achieved at the lowest density (5×10^{11} cm^{-2}). But, the high field velocity and saturation properties are a definite function of the carrier density. Only scatterings due to the acoustic phonon and the K-point intervalley optical phonon were considered in the simulation. First order TA scattering and ripple modes have been considered but do not contribute to these results[4]. As the density increases, the onset value increases and the saturation velocity decreases. These effects are due to graphene's unique bandstructure, which is governed by Dirac-like behavior near the zero band gap at the K and K' points in the zone. At low density, the Fermi energy lies very close to the Dirac point and therefore the electrons have smaller effective mass than their counterparts at high density. Due to this smaller mass, they can achieve higher saturation velocity. Furthermore, electrons can gain momentum faster at lower density. But the energy and the scattering also increase with increasing momentum and, as a result, the onset of velocity saturation occurs earlier, at a lower field, than for higher density. Similar saturating behaviors were also reported before for carbon nanotubes and top gated graphene field effect devices[5,6]. The low density velocity saturation suggests that graphene can be a good choice for low power application.

[1] A. H. Castro Neto *et al.*, *Rev. Mod. Phys.*, vol 81, p. 109 (2009), [2] K. S. Novoselov *et al.*, *Science*, vol 306, p. 666 (2004), [3] F. Chen *et al.*, *Nano Lett.*, submitted for publication; R. S. Shishir *et al.*, *submitted for publication*, [4] R. S. Shishir *et al.*, *J. Comp. Electr.*, *submitted for publication*, [5] A. Verma *et al.*, *J. of Appl. Phys.*, vol 97, p. 114319 (2005), [6] I. Meric *et al.*, *Nature Nanotech.*, vol 3, p. 654 (2008)

上記の詳しい講義内容に関しましては、下記にご連絡お願いします。

〒263-8522　千葉市稲毛区弥生町 1-33
千葉大学大学院　融合科学研究科　落合勇一
Tel:043-290-3428,　Fax:043-290-3427
E-mail: ochiai@faculty.chiba-u.jp