Graphene

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PREFACE

Graphene

Guest Editors

John Singleton
National High Magnetic Field Laboratory, Los Alamos National Laboratory, USA

David K Ferry
Department of Electrical Engineering, Arizona State University, USA

As is now well known, graphene was made in 2004 by the 'simple' expedient of cleaving a single atomic layer from a sample of graphite using a piece of sticky tape [1, 2]. This discovery stimulated a whirlwind of activity; at last, predictions about the unique behaviour of band electrons in a two-dimensional honeycomb lattice made as early as the 1940s could be verified experimentally [1, 2]. Perhaps the most influential result has been the confirmation that the charge carriers in graphene behave in many ways as 'Dirac fermions', mimicing the dynamics of hyper-relativistic electrons, but with 1/300th of the velocity. Another important pairing of prediction and result has been the observation of carrier mobilities that have an unusual (in)dependence on impurity concentration, suggesting applications in high-speed ballistic transistors and even the eventual part replacement of silicon by graphene as the devices on chips become ever smaller [1, 2].

As a result of the considerable and rapid activity in this field, reviews of the properties of graphene have appeared; a good introduction to the early work at a level appropriate to students is given in [1], whilst [2] covers more recent progress at a more advanced level. However, the field is progressing so rapidly that even good reviews become dated by the time they appear in print, and new work and studies are appearing daily.

In this issue, we have tried to pull together a group of papers which examine some of these new areas of work in graphene; these range from low-temperature physics to high electric field transport at room temperature [3]. Given the postulated future use of graphene in ultra-small devices, it is no surprise that quantum dots and wires feature heavily in the articles by Peres *et al* [4], Huang *et al* [5] and Sun and Xie [6]. Moreover, applications will inevitably involve graphene in contact with other materials and chemical systems, resulting in modifications to its electronic properties. For example, recent studies have shown that a high K dielectric solvent screens the impurities for room temperature transport in graphene, giving what is probably the intrinsic, phonon limited mobility at room temperature; this discovery and an analysis of the data form part of the article by Shishir and Ferry [7]. Continuing in the same vein, elsewhere Boukhvalov and Katsnelson [8] discuss chemical functionalization of graphene and Mucha-Kruczyński *et al* [9] covers the influence of the substrate. Finally, graphene has been referred to (somewhat optimistically!) as the 'mother of all carbon-based systems' [1]; graphite is a stack of graphene layers, whilst buckyballs and carbon nanotubes are wrapped-up and rolled-up graphene, respectively. Consequently, and following the discovery of graphene, there has been something of an *experimental* push to show that related physics may occur in graphite [10] and in organic conductors and other materials where the layers are very weakly coupled [11]; such phenomena had been expected by theoreticians for some years [11]. With this in mind, the article by Yaguchi and Singleton [12] reviews some of the field-induced states in graphite, in the hope that further cross-fertilization between graphene and its bulk relatives [10, 11] can occur.

We hope that readers will enjoy these additions to the body of work that represents our understanding of graphene.

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