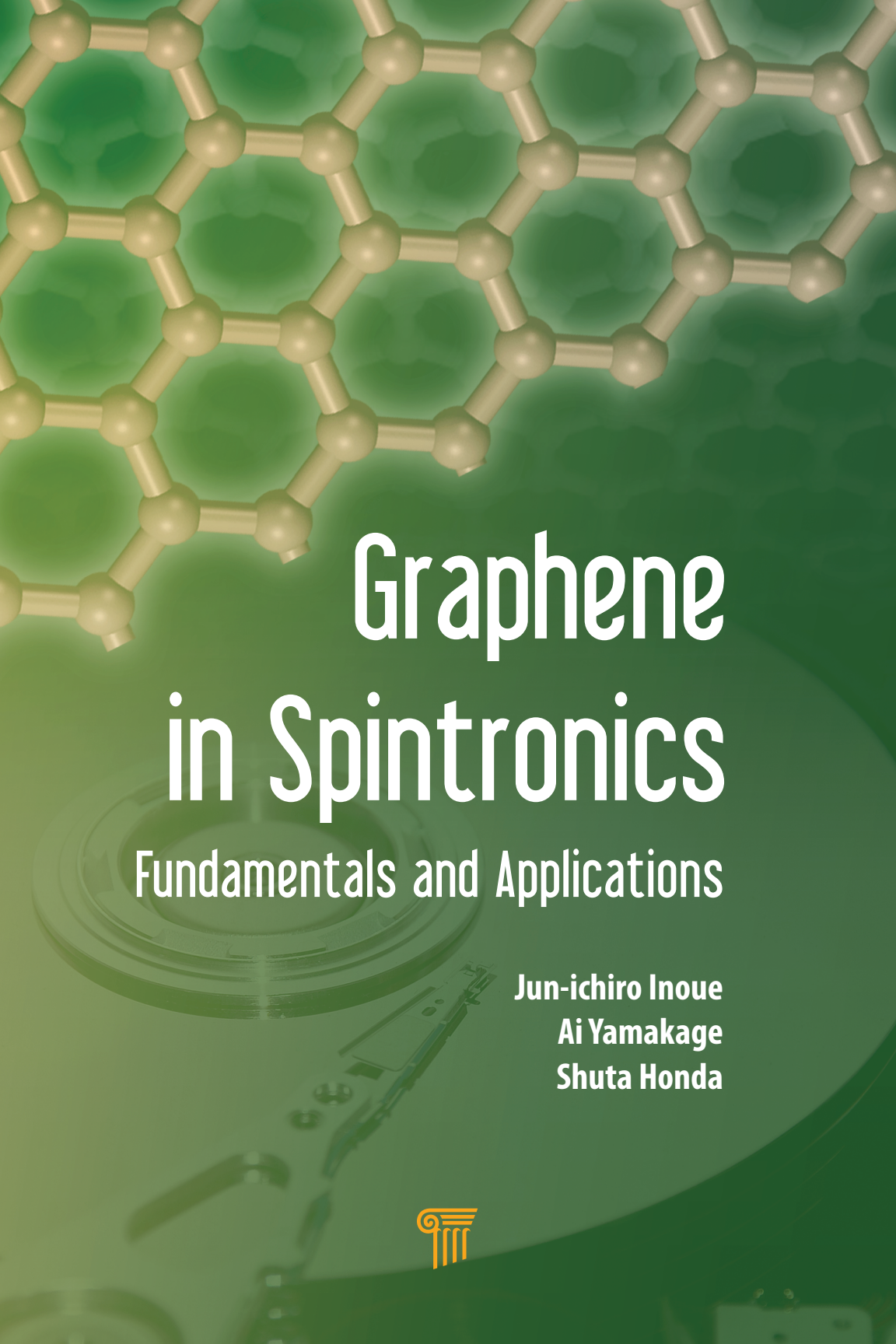

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Fundamentals and Applications

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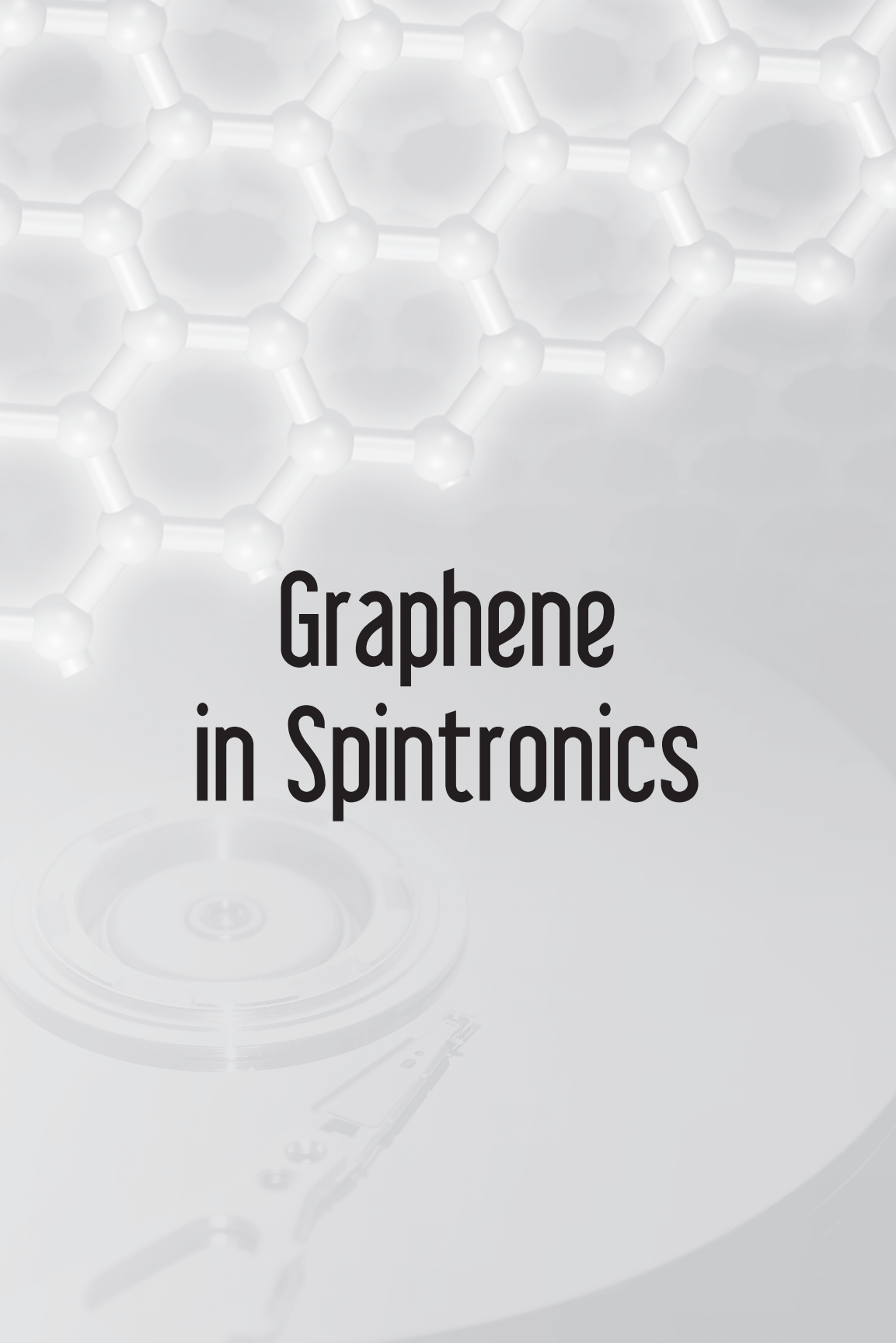
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Preface

In these 30 to 40 years, significant progress has been achieved in solid-state physics and materials science. Not only the discovery of novel materials such as oxide superconductors with high Curie temperature, magnetic multilayers with giant magnetoresistance (GMR), and low-dimensional carbon lattices called fullerenes, nanotubes, and graphene but also the discovery of the quantum version of Hall effects and the invention of the novel scanning microscope, etc., have been made.

Modern electronics based on solid-state silicon transistors has also developed tremendously due to the development of microlithography techniques and contributed to the progress in information-based society. Silicon electronics, however, is known to be confronted with difficulties caused by the downsizing of devices. Enormous scientific and technological research has been performed to overcome the difficulties. Among them, a novel way, the so-called spintronics, which utilized both spin and charge degrees of freedom of electrons, has been developed.

Previously the spin and charge degrees of freedom of electrons have been used independently for magnetism and semiconductor technology, respectively. The discovery of GMR opened the way for spintronics because GMR is a combined phenomenon of the magnetism and transport originated from electrons. The effect of magnetoresistance has been successfully applied in the field of spintronics, and further applications to silicon technology are under investigation. As mentioned, the discovery of novel materials opens up the option for scientists and engineers to use them for spintronics applications.

Graphene is a promising material for technological applications because of its distinguished physical and chemical properties. It

is, therefore, our obligation to proceed toward establishment of graphene technology. However, such an attempt is yet unsuccessful in modern electronics as well as in the field of spintronics. To bring about any scientific and technological breakthrough, an overview of the wide aspects of graphene and spintronics would be desirable. Because many excellent review articles and textbooks on each subject have already been published, it is our attempt to provide especially young scientists with an introductory view of graphene magnetoresistive junctions in relation to the present status of the field of spintronics.

The contents of this book are as follows. After a short introduction of graphene and spintronics, we present basic features of graphene in Chapter 2. The electronic structure of graphene, graphene nanoribbons, and graphene contacts are presented in Chapter 3. Transport properties relevant to graphene junctions, graphene field-effect transistors, and spin injection and magnetoresistance will be explained in Chapter 4. To give insight into the spintronics applications of magnetoresistive junctions, properties of GMR and tunnel magnetoresistance (TMR) will be explained in Chapter 5. Subsequently, theoretical results obtained by our group for magnetoresistance in realistic models will be presented in Chapter 6. In the final chapter, a summary and an overview will be given.

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