

Preface

This book presents the recent development in the area of spin dynamics and magnetic damping. It is important to understand the basic physical phenomena that govern the spin dynamics in the ferromagnetic thin films and nanostructures along with its application potential in data storage, memory, and communication technology. One of the crucial parameters that govern the spin dynamics is magnetic damping. The book begins with introducing spin dynamics with a perspective of quantum mechanical approach. The phenomenological Landau–Lifshitz–Gilbert (LLG) equation describing magnetization dynamics and also where the Gilbert damping appears is introduced subsequently. Discussion about the origin and mechanism (e.g., intrinsic and extrinsic, local and non-local) of damping is included. Existing theoretical models, e.g., breathing Fermi surface model, *s-d*-exchange relaxation model, spin-flip scattering along with their limitations in describing recent results are covered in reasonable detail. These descriptions are included for broad range of readers including graduate students. We have discussed the important experimental techniques for investigating magnetization dynamics starting from elementary level. Effect of material parameter, and electrical and optical control of magnetization dynamics are discussed along with recent development in this field of research.

The main highlights of the book are new experimental approaches for controlling damping in ferromagnetic thin films and nanostructures. The mechanism for the damping control in metallic ferromagnet/non-magnetic metal bilayer film is given emphasis keeping in mind its usefulness in spintronics-based devices. Various ways to tune the damping, specifically, dynamic (using spin current from spin Hall effect) and static control (interface intermixing) in ferromagnetic layer/heavy metal layer are described. For the investigation of modulation of damping, all-optical detection techniques, for example, time-resolved magneto-optical Kerr effect microscope and Brillouin light scattering technique, are discussed, in particular giving emphasis to the advantages of implementing them. Specifically, experimental results for Pt/Ni₈₁Fe₁₉ bilayer stack have been described in detail. A new method for estimation of spin Hall angle using all-optical detection technique is shown to be more appropriate as it excludes several sources of error that are present in electrical detection techniques. Furthermore, the results

of large spin Hall angle material in achieving larger modulation of damping are presented. To best of our knowledge, these results have been published quite recently in scientific journals and are described for the first time in such great detail to become part of a book. Invoking the concept of dynamic and static control of damping is another unique feature of this book. We thus hope that this book provides up-to-date overview of spin dynamics and magnetic damping along with future outlook which will be useful for graduate students as well as advanced researchers working in this field.

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