Preface

The special edition presents contemporary research results and engineering advances in steel and alloy science, with particular emphasis on the interplay among metallurgy, structural and mechanical performance and processing technologies.

Chapter 1: Metallurgy and Processing of Steel and Alloys focuses on the fundamental and applied aspects of the synthesis and processing of steel and alloys. It addresses phase transformations, microstructural evolution, and other factors governing the behaviour of conventional steels, alloys, and emerging materials, such as high-entropy alloys. Special attention is devoted to the relationship between processing routes and resulting mechanical properties. The chapter further explores modern processing technologies, including underwater welding, additive manufacturing, and powder metallurgy. These processing approaches introduce new and wide opportunities in modern mechanical engineering.

Chapter 2: Fatigue, Fractography and Failure Analysis examines the performance and durability of steel and alloy components under service conditions. Fatigue remains one of the most critical mechanisms limiting structural integrity in engineering applications. This chapter presents theoretical and experimental perspectives on fracture mechanics and fatigue testing methodologies, as well as on crack initiation and propagation. Particular emphasis is placed on fractographic analysis as a diagnostic tool for identifying failure mechanisms and correlating them with microstructural features and processing history.

It is our hope that this special edition will serve researchers, engineers, and industry professionals as both a reference and a source of inspiration, fostering innovation in the development and application of steels and advanced alloys in demanding structural environments.