Preface

Laser shock processing, or laser shock peening (LSP), is the process of hardening or strengthening metal using a powerful laser. It can generate a layer of residual compressive stress on a surface of metallic materials and alloys that is four times deeper than that attainable from conventional shot peening treatments (shot peening), which has been successfully applied to improve fatigue performance of metallic components.

In the past three decades, LSP has been widely and intensively investigated over 200 scientific papers and reports. Most studies and investigations have been based on experimental approaches, influences of LSP on mechanical properties and in particular fatigue lives of metallic materials and alloys. Many researches have been focusing on analytical models and dynamic finite element models (FEM), to simulate the distribution of three-dimensional residual stresses in relation to materials properties, component geometry, laser sources, and LSP parameters in the last decade. LSP is also an effective surface treatment and post-processing method to eliminate tensile residual stress in the surface layer of metallic material and its weldment in order to improve their mechanical properties and tensile performances.

In this book, we take the face-centered cubic metals (FCC metals, including aluminum alloy and austenitic stainless steel) and stainless steel weldment as the studied objects. The aim of this book is to provide some foundational researches on the macro-property, micro-structure evolution, and plastic deformation induced by massive LSP impacts. These researches can provide some scientific insights into the industry application of LSP technology. Some different topics are involved, i.e., surface integrity and fatigue lives of FCC metals after LSP with different processing parameters, tensile property, and fractural morphology of FCC metals by LSP under different strain-rates, grain refinement mechanism based on the micro-structure evolution, and corrosion behaviors after multiple LSP impacts. Special attentions have been paid to the effects of LSP on mechanical properties and tensile performance of stainless steel weldment.

For a better understanding on the effects of LSP on the macro-properties and micro-structures, and in order to obtain the appropriate LSP processing criterion by addressing the various factors mentioned above, a lot of LSP experiments are

carried out, and finite element simulation based on mechanistic modeling is currently recognized as an effective tool to analyze the distribution of residual stress. Some influential parameters associated with LSP are evaluated for the purpose of characterizing LSP processes. In particular, different methods of using LSP, such as one-sided, two-sided, and multiple LSP impacts on the FCC metals are elaborated in detail.

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