Preface

This book is a collection of the accepted papers concerning Advanced Materials in Machine Design. Depending on the scale at which they are analyzed and used, we can talk about composites, nanocomposites, nanomaterials and intelligent materials, e.g. such as piezoelectric materials, magnetorestrictive materials, functional (Shape Memory Alloys - SMA) materials. Intelligent materials are an important aspect of modern science and technology with applications in mechanical engineering.

Materials with multifield coupling properties are an important aspect of modern science and technology with applications in many industrial fields. It is well known that most materials are inhomogeneous. Inhomogeneous materials exhibit complex properties at both microscopic level due to their anisotropy and interaction between components. There are applied different models of description of material properties. It is often necessary, therefore, optimization of the structure due to the use in a suitable manner on the anisotropic properties of the material.

The research concerning optimal design of structures (especially laminated structures with piezoelectric layers) is spread on various areas dependent on the type of structures considered (i.e. beams, plates, shells etc.) and on the type of the response of structures subjected to the control (e.g. deformations, buckling, eigenfrequencies etc.). The forms of the objective functions, design variables and optimization algorithms are also different and depend on the particular engineering applications. The optimization has to take care of additional complexities arising due to the material properties (especially when used smart materials, multilayered composite structures).

Widely understood miniaturization puts increasing demands, which do not comply the classic material. Designing new materials with specific properties it is aiming at the nanometer scale intensively working on nanomaterials.
The efficient and effective use of materials in design applications is directly connected with the good knowledge of the static and fatigue strengths of the material. Typically, the variability in material parameters makes it difficult to accurately predict the response of structural components and significantly affects the reliability of designs.

The detection and control of damages and the study of their effects on the mechanical behavior of materials (especially composite structures) become important practical issues. The use of monitoring techniques (so-called Structural Health Monitoring – SHM) as non-destructive methods for detection of damages in beam, plate and shell structures is currently a research field of significance, particularly with recent development in the field of piezoelectric based smart structures.

The main contents of this book were collected from the authors' recent research outcomes and the research achievements of others in this field. Different parts of the research presented here were partially conducted by the authors.
The book is intended for researchers, engineers, designers and students interested in the materials and their use in the mechanical engineering.

The fundamental aim of the book is:

- To expand design horizons with a thorough, interdisciplinary knowledge of mechanics of materials, design optimization techniques, numerical methods, materials science, manufacturing processes and smart materials;
- To cover a more complete and a broad spectrum of current problems and scientific researches in the area of the design of materials and structures;
- To highlight an entire range of possibilities of the use of various materials for different problems encountered in practice – it demonstrates the advisability and sense of their use;
- To focus on the importance and significance of taking into account advanced materials in machine design and further in the optimization of their properties.

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Prof. Aleksander Muc

Dr. Marek Barski

Dr. Piotr Kędziora