

The Book of Critical Technologies of Surface and Properties Formation of Engineering Materials

Anna D. Dobrzańska-Danikiewicz

Faculty of Mechanical Engineering, Silesian University of Technology,
Konarskiego St. 18a, 44-100 Gliwice, Poland

Corresponding e-mail address: anna.dobrzanska-danikiewicz@polsl.pl

Abstract

Purpose: *The purpose of this book is to establish and harmonise knowledge on the most promising, critical technologies of structure and properties formation of surface layers and coatings of different engineering materials using a developed and verified experimentally, original custom methodology of the computer-integrated prediction of such technologies' development. This methodology employs heuristic research of strategic knowledge management, using the technology e-foresight method, through a multi-stage examination of experts' opinions with the e-Delphix method, together with the preparation of contextual matrices, roadmaps and technology information sheets provided in the book. The newly established methodology also serves to create alternative scenarios of future events connected with the forecast development directions of the analysed technologies, aided by information technology. The information technology applied encompasses virtual organisation, web platform and artificial neural networks, in conjunction with modelling with the Monte Carlo method. The research undertaken is aimed at the dissemination of the knowledge acquired and at facilitating the effective transfer of the analysed technologies to industrial establishments, especially micro-, small- and medium-sized enterprises and at commercialising such knowledge, in particular by developing a custom concept of technology e-transfer.*

Design/methodology/approach: *The book uses a complex methodological apparatus, representing an author's achievement, serving to diagnose the key scientific, technological, economic and ecological issues in the area of engineering materials surface engineering and to identify the directions of its strategic development and related decision-making. New, custom technology e-foresight methods were applied connected with creating an original computer system based on a web platform and virtual organisation, enabling, most of all, to conduct on-line surveys with the e-Delphix method. The computer system also enables to determine alternative scenarios of future events based on the developed, author's SCENNET21 and SCENNET48 software using artificial neural networks. 140 selected priority technologies, out of approx. 500 technologies, were characterised and compared as a result of the detailed works carried out, with such technologies being classified within two thematic fields representing a process and consumer approach.*

Findings: *The underlying scientific, but also applicational accomplishment of this book is that the strategic position of 140 critical technologies of structure and properties formation of engineering materials was selected, characterised and determined in a clear and harmonised manner, and that strategic directions and multi-variant probabilistic scenarios of such technologies' development were set up. The outcomes were summarised of the author works conducted so far with participation of a team of experts composed of nearly 500 persons, with such works carried out in the framework of an organised system of co-operation and acquisition of hidden knowledge possessed by each of the experts and with such knowledge being converted into openly available knowledge. The openly available knowledge can be processed and harmonised in order to establish the development*

forecasts of each of analysed technologies and to set general tendencies and general development trends in the context of the development of domestic economy or even in a global scale. An interdisciplinary, custom methodology of the computer-integrated prediction of the development of materials surface engineering, applied for the performance of heuristic research, the outcomes of which are described in the book, has also its universal value and can be easily applied for any other technological area. This, however, can happen on the condition that appropriately extensive e-foresight research is pursued using the custom e-Delphix method and with participation of a team of several hundred experts selected appropriately. The e-foresight research method of computer-integrated diagnosis and prediction of development of any group of technologies using the e-Delphix method and information technology, encompassing virtual organisation, web platform and artificial neural networks, can be applied as the only method, without a need to pursue costly and time-consuming, classical materials-science research.

Research limitations/implications: The book presents conceptual assumptions of the technology e-transfer idea only, although organisational measures have already been undertaken for its practical implementation, confirming that it is possible, needed and necessary to implement the outcomes of the research performed in the economic reality at a macro-, mezo- and micro-level. It is too early, however, to present the outcomes of such works and for this reason they can be included in subsequent publications.

Practical implications: The knowledge made available in the book, especially as roadmaps and information sheets of 140 critical technologies and surface engineering development scenarios, can be used by entrepreneurs and other business units to employ such knowledge for the business activity conducted. Such knowledge can be used by local authorities and economic self-governments on a local and national level and applied in decision-making processes concerning the allocation of public funds and preparation of development strategies. The use of such knowledge in long term will serve to ensure a high quality of technologies implemented in enterprises and sustainable development and a stronger knowledge- and innovation-based economy, contributing to domestic economy's competitiveness. Surface treatment technologies need to be popularised through effective transfer to industrial plants and through commercialisation, as this issue is significant in economic terms. Moreover, many of the detailed surface treatment technologies and their technological variants are applied or may be applied in products manufactured using all the basic groups of engineering materials.

Originality/value: The book is original for its unconventional methodological approach to solving the research intentions undertaken. This approach, apart from classical analytical methods and tools, consists of original, created contextual matrices, roadmaps and technology information sheets provided in the book together with alternative scenarios of development, created with the aid of neural networks. The crowning of author accomplishments is a newly developed methodological concept of the e-transfer of technology using the state-of-the-art Internet Platform of Technology e-Transfer, holding a database of the priority innovative technologies of surface treatment of modern engineering materials, established in the framework of this scientific book. The long-term effects of the e-foresight research performed, broadly disseminated via the Internet – in line with the technology e-transfer concept – can be considered one of the crucial factors contributing to the accelerated sustainable development of Poland and Europe, a stronger knowledge- and innovation-based economy and statistical growth in the quality of the technologies used in industry.

Keywords Materials surface engineering; Knowledge and information management; Heuristic research; Technology e-foresight; Technology e-transfer; Technology roadmaps; Technology information sheets; Development scenarios

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Materials science is an interdisciplinary field involving the micro and nano-structure, processing, properties of materials and its applications to various areas of engineering, technology and industry. This book addresses all types of materials, including metals and alloys, polymers, ceramics and glasses, composites, nano-materials, biomaterials, etc. The relationship between micro and nano-structure, processing, properties of materials is discussed. Surface engineering is a truly interdisciplinary topic in materials science that deals with the surface of solid matter. Key Features. Surface engineering includes many facets of materials science that help regulate the function, quality, and safety of products such as automotive, textile, and electronic materials. He is Senior Chartered Engineer by the Portuguese Institution of Engineers with an MBA and Specialist title in Engineering and Industrial Management. He is also Eur Ing by FEANI-Brussels and Fellow (FIET) by IET-London. In addition, he has also published as editor (and co-editor) more than 120 books and as author (and co-author) more than 10 books, 80 book chapters and 400 articles in journals and conferences (more than 250 articles in journals indexed in Web of Science core collection/h-index 52+/9000+ citations, SCOPUS/h-index 57+/11000+ citations, Google Scholar/h-index). This book covers a wide field of theoretical and experimental investigations of organic and inorganic systems: preparation methods, functional properties characterization and modification and practical applications. The first section includes studies in carbon structures of reduced dimensionality. Section 2 includes the chapters related to preparation methods for the materials containing various components. It is opened by research of nanoporous alumina, which is a promising material for printed circuit boards. Chapter 17. Activation of the Surface of Alumina Powders for Sintering Ceramics (S. P. Bogdanov, N. A. Khristyuk, V. V. Kozlov and A. Dolgin, Saint Petersburg State Institute of Technology, Saint Petersburg, Russia). Chapter 18.