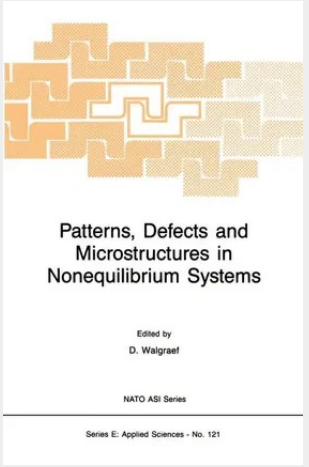
Walgraef

Patterns, Defects and Microstructures in Nonequilibrium Systems

Applications in Materials Science



One of the most fascinating and intriguing aspects of natural phenomena is that complex systems may undergo symme try-breaking instabilities leading to pattern formation or coherent temporal behavior over macroscopic space and time scales. Therefore the understanding of why order may appear spontananeously in open systems far from equilibrium and which planforms are selected among a large manifold of possi bilities has become a major theme of research both theore- cally and experimentally. These studies, first related to fundamental questions, appear now to be of technological importance, especially for materials science problems. Effectively during the last years, the whole field of materials science experienced a complete renewal. By using techniques able to operate in strong nonequilibrium conditions and hence to escape from the constraints of equilibrium thermodynamics, totally new mate rials structures have been processed. Such techniques inclu de ion implantation, laser beam surface melting as well as electron beam heating. For example, ion implantation proces sing is able to create surfaces with compositions markedly different from the bulk, leading to materials having new electric, magnetic or chemical properties. In laser annea ling, after the tremendously rapid melting and recrystalliza tion of the sample surfaces, microstructures with superior resistance to friction, corrosion, ••• are frozen into place. Rapid solidification of alloys trigger the formation of quasi-crystalline structures. Ion beam mixing can modify the electrical properties of polymers or improve the adhesion of metallic films to ceramics.

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213,99 €
199,99 € (zzgl. MwSt.)

Nicht mehr lieferbar

Artikelnummer: 9789401080927
Medium: Buch
ISBN: 978-94-010-8092-7
Verlag: Springer
Erscheinungstermin: 17.10.2011
Sprache(n): Englisch
Auflage: Softcover Nachdruck of the Original 1. 1987 Auflage 2011
Serie: NATO Science Series E:
Produktform: Kartoniert
Gewicht: 604 g
Seiten: 378
Format (B x H): 155 x 235 mm

Kundenservice Verlag Dr. Otto Schmidt KG
Neumannstraße 10, 40235 Düsseldorf | kundenservice@otto-schmidt.de | 0221-93738-997 (Inland)