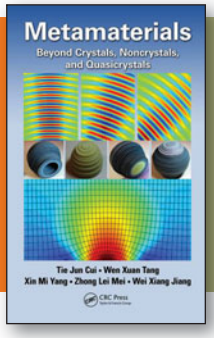
multicomponent liquid alloys with their constituent subsystems, and (4) identify inter-property relationships (surface tension, viscosity, and diffusion viscosity) for specific cases. The second chapter describes the experimental procedures applied to liquid alloys and their limitations, with an emphasis on levitation methods. The following three chapters discuss the density, surface tension, and viscosity following the same pattern: theory, experimental data for pure metals, their binary liquids, and, if available, their ternary liquids. The end of each chapter discusses Brillo's four questions and summarizes them.

The last three chapters cover the inter-property relations of liquid alloys, the solid–liquid and liquid–liquid interfacial energies of specific systems, and the thermophysical properties of some liquid Ga-Mn-Ni alloys (which provide magnetic shape-memory alloys), and present an overall discussion and conclusion. The two appendices present all of the experimental data on liquid alloys determined by Brillo's research group. Brillo did not provide a general rule for prediction of excess volumes or other thermophysical properties of the evaluated liquid pure metal and some of their binary and ternary alloys.

This book will be valuable to newcomers to the field thanks to its explanations of the different properties of liquid metals, and also to senior researchers and engineers working with liquid metals or in parallel fields due to its large amount of experimental and assessed data.

***Reviewer: Roberto Ribeiro de Avillez** of Pontifícia Universidade Católica do Rio de Janeiro, Brazil.*



Metamaterials: Beyond Crystals, Noncrystals, and Quasicrystals

Tie Jun Cui, Wen Xuan Tang, Xin Mi Yang, Zhong Lei Mei, and Wei Xiang Jiang

CRC Press, 2016
341 pages, $175.96 (e-book $153.97)
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Metamaterials are materials consisting of small manmade structures, "meta-atoms," arranged regularly (crystal-like) or randomly (such as in an amorphous material), similar to atoms in a conventional material. The focus of this book is the interaction of electromagnetic waves with these materials. The most famous metamaterials are those with a negative index of refraction and materials to be used for "invisibility cloaks." The theoretical description of the properties of these materials, explained in the introductory chapters, is based on Maxwell's equations and other laws and is derived therein from Maxwell's equations. This means that physicists and most materials scientists should have no difficulty following the mathematical descriptions.

The frequency range discussed in this book is limited to microwaves. A special chapter is devoted to each type of metamaterial, highly ordered super crystals, random metamaterials, super noncrystals, and inhomogeneous metamaterials called "super quasicrystals." Special groups of materials—gradient and two-dimensional metamaterials—are also discussed. The properties of each of these are discussed in detail. However, in most cases, the authors give only the final equations describing the properties and do not show enough to determine how to deduce them. In most cases, this is sufficient for the reader interested in applications. The synthesis of metamaterials is not described at all; the book is limited to the properties.

Even though the content of this book is based primarily on work conducted in the State Key Laboratory of Millimeter Waves at the Southeast University in China, the authors took care to include references to the international literature in this area. Each chapter is followed by a long list of articles from the literature. Visualization of the information is accomplished with a large number (203) of very instructive figures. This book is recommended to every materials scientist who wants to apply or learn more about this new class of materials. However, as this book (1) is largely limited to the interaction of electromagnetic waves with metamaterials and (2) does not cover questions of synthesis, it is not suitable as a basis for a course on metamaterials.

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