

BOOK REVIEW

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About the book ‘Negative Refraction of Waves’ by O.D. Vol’pian and A.I. Kuzmichev (Kiev – Moscow: Avers, 2012. – 359 p., 203 references)

A.V. Masalov

The publishing house ‘Avers’ has published O.D. Vol’pian’s and A.I. Kuzmichev’s book ‘Negative Refraction of Waves’. In recent years the topic of negative refraction has become fashionable. Apparently, realising this, the authors have provided the book with the subtitle: ‘Introduction to Physics and Technology of Electromagnetic Materials’. The subtitle rather accurately describes the content of the book. Acquaintance with it suggests that this book is not an attempt to follow the fashion, but a very thorough review of recent achievements in the development of artificial media, i.e., metamaterials that have unusual reactions to electromagnetic radiation. The authors focus on negative-index metamaterials. In the surrounding nature such material are absent (a possible exception are rare exotic examples). Therefore, until recently, the developers of devices that use electromagnetic radiation have not even thought of using negative-index media. Today, the situation has drastically changed. Progress in the fabrication of negative-index media makes it possible to implement new, highly unexpected capabilities – lenses for sub-diffraction-limited imaging, invisibility cloaking, etc. Today, dozens of scientific laboratories around the world are involved in successful development of metamaterials. Among the scientific community there has appeared a new paradigm: how and from what elements to fabricate negative-index metamaterials. A necessary (but not sufficient) condition for the materials is the small size of the structural elements compared to the wavelength of electromagnetic radiation. Therefore, this book is a very good overview of the ideas and success in this direction.

The presentation of the material in the book begins with a historical chapter, which shows how the concepts of negative refraction were put forward in the last century (from its beginning). The chapter also describes in detail the contribution of Russian scientists and some sections of the chapter are devoted to the key ideas in this area, expressed by L.I. Mandelstam and V.G. Veselago.

The main content of the book is divided into two parts. The first part describes the techniques for engineering negative-index media in the gigahertz range of the electromagnetic radiation. There are many examples of successful developments. In this range, fabrication of artificial materials does

not require nanotechnology, and it is sufficient to use composites made of sub-centimetre artificial elements. Therefore, great practical advances have been achieved in the development of metamaterials in the gigahertz wavelength range. The examples described in this part of the book are interesting in that the authors manage to trace the relationship of the electromagnetic properties of individual structural elements with the properties of the material as a whole.

The second part of the book describes the ideas and advances in the development of negative-index metamaterials in the optical range of the electromagnetic radiation. Here, the difficulties of experimenters and developers are associated with the limitations of modern nanotechnology, since the medium should consist of submicron-sized elements. Therefore, progress in this area is hampered.

Besides, the material of both parts of the book is successfully supplemented with the sections about the so-called gradient metamaterials. Because of the specific fabrication technology these structures may be useful in some applications.

At the end the book also provides with some useful information about metamaterials constructed in the form of arrays and about the technological aspects of obtaining metamaterials.

The overwhelming part of the text of the book consists of descriptions of the practical results and abounds in graphic material. The authors prefer the qualitative picture of the phenomena, and the figures and graphics from the original works are adapted in such a way as not to violate the logical unity of the presentation. The authors do not conduct a review of the theoretical models aimed at describing and predicting the properties of metamaterials. Such a review would significantly increase the size of the book, but would not greatly expand the circle of interested readers. However, the book contains a sufficient number of formulas needed to estimate the effects discussed. For the reader with an engineering degree this information can serve as a great help.

In general, the book will be undoubtedly of interest to students, postgraduates, engineers, and scientists, as a good introduction to the metamaterials science, where we can expect unusual discoveries and unexpected applications of the results in the next few years.

A.V. Masalov P.N. Lebedev Physics Institute, Russian Academy of Sciences, Leninsky prosp. 53, 119991 Moscow, Russia;
e-mail: masalov@sci.lebedev.ru

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