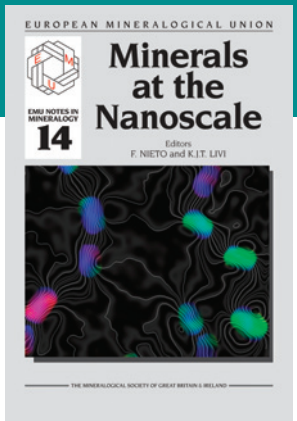
MINERALS AT THE NANOSCALE



Minerals at the Nanoscale is the European Mineralogical Union's most recently released volume in its series EMU Notes in Mineralogy. The overall series has been exceptionally well done since the first volume in 1997, and this latest volume (#14, published in 2013) follows in that tradition. To be honest, the only aspect of the entire book that I found less than ideal was the title. Is the book about minerals that are literally at the nanoscale, meaning it is about nanomineralogy, a burgeoning field in the study of nanominerals and mineral nanoparticles, or is it about the study of macroscopic minerals using techniques that give us insight into their characteristics and behavior at the nanoscale? Although this book considers both aspects, it is primarily about the latter. Nine of the eleven chapters are mainly concerned with the study of macroscopic minerals at nanoscale levels, while the two remaining chapters cover vitally important segments of the nanomineral world: clays, which are typically nanoscale in one dimension, and nanosized iron, aluminum, and manganese oxides. From that point of view, the book is quite unbalanced, but there is in fact one clear common denominator that holds the entire book together, that being the use of transmission electron microscopy (TEM) and its associated techniques as the primary toolkit for studying all the fascinating nanoscale angles that this book explores.

The technical editors of this book, Fernando Nieto of the University of Granada, Granada, Spain, and Ken Livi of Johns Hopkins University in Baltimore, Maryland, USA, both have long and distinguished histories in the use of TEM and related techniques in geologic and environmental science research. Further, the chapters in *Minerals at the Nanoscale* originated from lectures given at the 13th EMU School held at the University of Granada in June 2013. I find it remarkable that this volume appeared only a month or two after the conference. What a great example for all of us to follow, publishing so very rapidly when delays at each stage are more commonly the norm. Here is a new book where the science is still very fresh and completely up to date.

The first transmission electron microscope was built a little more than 80 years ago, with the first commercial instruments available shortly thereafter in 1939. What is perhaps most surprising to me is not that so much progress was made with the technique in the early years but that, all these decades later, TEM is still advancing at an astounding rate and is today used far more than ever before in nearly every branch of physical and biological science and engineering. This revolution has certainly not been lost on geoscientists and environmental scientists, with the exceptionally versatile TEM technique contributing more and more every year. Imaging resolution has now achieved 0.5 Å (= 0.05 nm) using aberration-corrected columns. But TEM instruments also offer electron diffraction for material identification and crystallographic work, energy-dispersive X-ray spectroscopy (EDS) for chemical analysis, and electron energy loss spectroscopy (EELS) for chemical analysis and oxidation state information. They also provide spectacular 3-D tomography even below one-nanometer resolution using high-angle annular dark-field (HAADF) detectors and state-of-the-art scanning TEM (STEM). Much simpler and more affordable cells are available now for working in gaseous and liquid environments at various temperatures. Results have been spectacular, to say the least. Is the modern TEM instrument the most versatile tool in mineralogy today? Whatever your opinion is concerning this question, most will probably agree that volume 14 of the EMU Notes in Mineralogy series presents outstanding example after outstanding example of forefront mineral science based primarily on recent TEM research.

The 11 chapters in this book are written by an international cast of well-known and highly accomplished experts in TEM-based mineral research, who discuss applications from mineral physics to soil science, and from metamorphic petrology to biominerals and environmental science. In general, it is well beyond the scope of this book to teach or instruct in the theory, fundamentals, techniques, and applications of TEM. Several excellent comprehensive texts (sometimes in multiple volumes) are available for this. Nevertheless, in this EMU book, parts of chapters are devoted to sample preparation, a procedure that is exceptionally critical but nearly always challenging in most TEM studies, as well as to imaging methods and analytical techniques (EDX and EELS). The portions of the chapters that hold this information will be most useful to those who are not at least somewhat familiar with TEM instruments and technology. Even if you have no TEM background, this book will guide you well inside the world of science that explores the underlying roots of mineral atomic and defect structure and mineral physical/chemical behavior.

Any volume in the EMU Notes in Mineralogy series, including *Minerals at the Nanoscale*, can be purchased directly from the Mineralogical Society of Great Britain and Ireland (www.minersoc.org), or from the Mineralogical Society of America (www.minsocam.org).

Michael F. Hochella Jr., Virginia Tech

Nieto F, Livi KJT (eds) (2013) Minerals at the Nanoscale. EMU Notes in Mineralogy 14, European Mineralogical Union, ISBN: 978-0903056-34-2, xv + 440 pp, £40 (institutions) or £25.50 (individuals)