Bozena Arnold

Rubies and Implants

Aluminium oxide and Its Diverse Facets

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ISBN 978-3-662-66115-4 ISBN 978-3-662-66116-1 (eBook)
https://doi.org/10.1007/978-3-662-66116-1

This book is a translation of the original German edition "Von Rubinen und Implantaten" by Arnold, Bozena, published by Springer-Verlag GmbH, DE in 2018. The translation was done with the help of artificial intelligence (machine translation by the service DeepL.com). A subsequent human revision was done primarily in terms of content, so that the book will read stylistically differently from a conventional translation. Springer Nature works continuously to further the development of tools for the production of books and on the related technologies to support the authors.

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The registered company address is: Heidelberger Platz 3, 14197 Berlin, Germany

Preface

All substances are made up of atoms. Every substance has a certain chemical composition. It determines the basic properties of the substance. In addition, the internal structure of the substance plays a very important role and exerts a strong influence on its properties.

In particular, it is very interesting when the composition and structure are the same, but in practice there are different materials. In this case, a substance has different faces. Such a substance with two faces is aluminium oxide – in nature a mineral and in technology a high-performance material. The famous diamond can also be counted among these substances.

The present book is a popular-scientific treatise on the alumina, on a single substance and very different materials – famous gems and modern ceramic materials. The former are old and long known, the latter are young and developed only recently.

My fondness for materials developed and became more and more pronounced during my many years as a professor of materials engineering, most recently at the HAW University of Applied Sciences in Hamburg. My admiration for minerals and their natural origin has developed to a special degree after my retirement. From these two preferences the idea for this book was born.

The book is aimed at all those who have basic chemical and technical knowledge and are interested in materials without seeking in-depth scientific knowledge. If, however, curiosity for further information should be aroused while reading, the book has fulfilled an important task.

Waldbronn, Germany — Bozena Arnold
October 2017

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Fascinating Aluminium Oxide

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Aluminium oxide occurs as a mineral in nature, is used as a high-performance material in technology and it is fascinating in every case. Why actually?

Aluminium oxide – that sounds dry at first, like any chemical term. What is supposed to be fascinating about it? Why does one feel like writing a book about it?

On the upper floor of the German Gemstone Museum in Idar-Oberstein, rubies are displayed in a showcase. One specimen (Fig. 1.1a) has an amazingly homogeneous colour, the special pigeon's blood colour. The gemstone sparkles, it is beautiful and it is admired.

Now we visit a textile factory. Several weaving machines are working loudly and intensively. The fibres run at high speeds through ceramic yarn guides. Thermal stress, friction, surface wear and, in the case of fibres, also electrostatic effects in production challenge these small components. The yarn guide (Fig. 1.1b) is colourless, works hard and can hardly be seen. Nobody admires him.

Two objects that could not be more different. And yet they are actually the same. Both are made of the same material, have the same chemical composition.

The gemstone and the ceramic thread guide are made of aluminium oxide. This simple chemical compound has two distinct worlds: a natural one, full of beauty and desire, and an artificial one, full of work and technical stakes. One world is magical, laden with myth and desire, bringing good luck and bad luck, promising wealth and beauty. The second world is technical, dry, sophisticated, cool and very applied. Isn't that fascinating?

We can find the aluminium oxide in the earth's crust and then we call it corundum or ruby or sapphire. We can also produce it on a large scale and then we usually call it alumina. Chemically, in all of these cases, it is a compound of aluminum and oxygen. The corundum and the gemstones ruby and sapphire are the natural manifestations of the aluminium oxide. The artificial alumina is mainly needed for the production of aluminium. However, it is also used as a material for valuable ceramic components, e.g. for thread guides in the textile industry and for implants in medical technology.

B. Arnold, *Rubies and Implants*, https://doi.org/10.1007/978-3-662-66116-1_1