Industriemathematik und Angewandte Mathematik

Karl Gerald van den Boogaart

Statistics for individual crystallographic orientation measurements

Shaker Verlag
Aachen 2002

Die Deutsche Bibliothek - CIP-Einheitsaufnahme

van den Boogaart, Karl Gerald:
Statistics for individual crystallographic orientation measurements /
Karl Gerald van den Boogaart. Aachen : Shaker, 2002
(Industriemathematik und Angewandte Mathematik)
Zugl.: Freiberg, Univ., Diss., 2001
ISBN 3-8265-9782-6

Copyright Shaker Verlag 2002
All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the publishers.

Printed in Germany.

ISBN 3-8265-9782-6
ISSN 1615-6390

Shaker Verlag GmbH • P.O. BOX 1290 • D-52013 Aachen
Phone: 0049/2407/9596-0 • Telefax: 0049/2407/9596-9
Internet: www.shaker.de • eMail: info@shaker.de

The objective of the thesis is the development of methods for the statistical analysis of crystallographic orientation data stemming from automated electron back scatter diffraction (EBSD) orientation measurements. Crystallographic orientations differ from other statistical data by their scale and their spatial dependence. As left cosets of rotations they do not belong to any of common scales of statistical data, and for physical reasons they do not generally comply with the independence assumption of classical statistics.

To handle this non–linear scale the statistical moments are replaced by the C–coefficient derived from the characteristic representations of the corresponding group. They provide a simple method to consider crystallographic symmetries and to correct estimators for their bias. Moreover, the crystallographic exponential family is introduced for this scale. Two independent and complementary stochastic models of the spatial dependence are developed and applied to infer the variance of estimators. The first approach, motivated by the notion of crystal grains, allows to infer the estimation error based on knowledge of the microstructure. It requires some restrictive assumptions concerning the interaction between grains. The second approach, motivated by spatial statistics, is based on the sole assumption of a known finite range of dependence and applies generally.

The theory provides for the first time the meams to do quantitative orientation data analysis. On a sound mathematical basis it spans the frame to adapt methods of multivariate data analysis and apply statistical tests, texture regression, texture discrimination, inverse texture regression and simulation conditional to a distribution and a spatial dependence estimated from experimental data.