

University of Groningen

The Colouration of Bird Feathers explained by Effective-Medium Multilayer Modelling

Freyer, Pascal

DOI:
[10.33612/diss.150815549](https://doi.org/10.33612/diss.150815549)

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2021

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):
Freyer, P. (2021). *The Colouration of Bird Feathers explained by Effective-Medium Multilayer Modelling*. [Thesis fully internal (DIV), University of Groningen]. University of Groningen.
<https://doi.org/10.33612/diss.150815549>

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

The Colouration of Bird Feathers
explained by Effective-Medium Multilayer Modelling

Pascal Freyer



university of
 groningen

faculty of science
 and engineering

zernike institute for
 advanced materials

The Colouration of Bird Feathers explained by Effective-Medium Multilayer Modelling

Pascal Freyer

PhD thesis

University of Groningen

Cover images: Micrographs of blue and yellow peacock feather barbules (enlarged by a factor of about 5000) and an insert of the original page 169 of Robert Hooke's *MICROGRAPHIA: or some physiological descriptions of minute bodies made by magnifying glasses* (1665).

Layout: Wanda Reen and Pascal Freyer.

Printed on recycled paper by: Gildeprint, Enschede, the Netherlands.

Zernike Institute PhD thesis number: 2021-01

ISSN: 1570-1530

The work described in this thesis was performed in the research group Surfaces and Thin Films of the Zernike Institute for Advanced Materials, University of Groningen as part of the research program financed by the Air Force Office of Scientific Research/ European Office of Aerospace Research and Development, AFOSR/EOARD (grant FA9550-15-1-0068).



university of
 groningen

The Colouration of Bird Feathers explained by Effective-Medium Multilayer Modelling

PhD thesis

to obtain the degree of PhD at the
 University of Groningen
 on the authority of the
 Rector Magnificus Prof. C. Wijmenga
 and in accordance with
 the decision by the College of Deans.

This thesis will be defended in public on

Tuesday 19 January 2021 at 11.00 hours

by

Pascal Freyer

born on 4 April 1990
 in Windhoek, Namibia

Promotores

Prof. P. Rudolf

Prof. D.G. Stavenga

Co-promotor

Dr.mult. C.J. van der Kooi

Assessment Committee

Prof. S. Vignolini

Prof. G. Palasantzas

Prof. H. Hölscher

To Larissa, to my family
and to the people and nature of Namibia.

CONTENTS

1. INTRODUCTION	9
2. Cortex thickness is key for the colours of bird feather barbules with a single melanosome layer	21
3. Reflections on iridescent neck and breast feathers of the peacock, <i>Pavo cristatus</i>	45
4. Biophotonics of diversely coloured peacock tail feathers	67
5. Wetting causes structure-dependent colour changes in bird feathers	89
6. GENERAL DISCUSSION AND OUTLOOK	101
Summary	107
Samenvatting	109
Zusammenfassung	111
Acknowledgements	115
The Author	119
List of Publications	119

