

Why Penguin Beaks are Sexy!

Stephen W. Carmichael¹

Mayo Clinic

carmichael.stephen@mayo.edu

It is well known that birds frequently attract mates by a ritual display of feathers or other ornaments. The colors for these displays are either derived from pigments, such as carotenoids, or photonic crystalline arrangements near the surface of the skin, feathers, or other ornaments. Add to this the fact that many birds can perceive light in the near-ultraviolet end of the visible spectrum and the range for these visual displays is extended. In a spectrophotometric and microscopic study by Birgitta Dresp and Keith Langley,² it was demonstrated that a unique arrangement of crystal-like structures near the surface of the beak horn of the King penguin (*Aptenodytes patagonicus*) most likely accounts for a photonic effect that probably plays a role in their mating rituals.

The beak of a King penguin is black, with an oval plate, called the beak horn, on its side. The beak horn is an oval structure about 8 cm long and 1.5 cm wide and 0.35 mm thick. It is molted annually, and these molted beak horns were collected on Possession Island (46° South, about 1,000 km from the coast of Antarctica and 2,350 km south of Madagascar). To the human eye they are yellow-orange in color and this is almost certainly due to carotenoids in the deeper layers. They also appear to have a pinkish-violet tint. In reflectance spectra, a peak was found around 370 nm, in the near-ultraviolet range. When the top layers were gradually scraped off, this reflectance peak was maintained until a certain depth had been scraped away. These and other experiments suggested that the region nearest the surface, which must be at least 10 microns thick to be reflective, is probably responsible for this reflectance and that it is not reinforced by deeper structures. This would play a role in nature when a beak horn was partially damaged, it would still have the same appearance.

Histologic examination revealed an appearance vaguely resembling mammalian keratinized stratified squamous epithelium. Nuclei were absent from the uppermost layers. Mammalian keratins consist mainly

of α -keratin whereas hard integument structures in birds (feathers, scales, etc.) are mostly composed of β -keratins, which form fine filaments with a twisted β -sheet structure. Dresp and Langley referred to an upper region, central region (with layers of cells), and a lower region (containing compact, clear, flat cellular profiles). It was when the upper region had been completely scraped away that the near-ultraviolet reflectance was lost. The central and lower regions are apparently the regenerative layers that maintain the structure for a year.

Examination by transmission electron microscopy revealed interconnected structures in the upper region. These consisted of layers (up to 40) of folded double membranes arranged in microstructures. Between these microstructures were filaments about 3.5 nm in diameter, which correlates with β -keratin filaments. These filaments apparently formed the scaffolding for the microstructures. The spacing between the folded membranes was around 130 nm. Bragg's Law ($n\lambda=2d \sin\theta$, where the relevant parameters are the diffracted wavelength λ , d is the distance between layers in the periodic array, and n is an integer) predicts the reflected wavelength to be about 378 nm, remarkably close to the experimentally measured value of 370 nm! This also elegantly illustrates the power of transmission electron microscopy to predict tissue properties.

Dresp and Langley concluded that coherent light scattering from the King penguin beak horn is caused by sunlight reflected from the microstructures they discovered. Whereas other studies have shown reflectance in the near-ultraviolet to be caused by photonic structures present in feathers and other structures, nothing like the microstructures seen in this study have been described previously. Also, this is the first time this has been characterized in beak tissue of any bird. It is certainly tempting to conclude that this unique structure in the beak horn of the King penguin plays a key role in the courtship behavior of this bird. ■

1. The author gratefully acknowledges Drs. Keith Langley and Birgitta Dresp for reviewing this article.
2. Dresp, B. and K. Langley, Fine structural dependence of ultraviolet reflections in the king penguin beak horn, *The Anatomical Record Part A* 288A:213-222, 2006.

INDEX OF ARTICLES

Why Penguin Beaks are Sexy!	3
<i>Stephen W. Carmichael, Mayo Clinic</i>	
A 'Different' Kind of Microscopy	6
<i>Fred Schamber and Kai van Beek, Aspx Corporation</i>	
Microwave Myths and Tissue Processing	14
<i>Phillip McArdle, Energy Beam Sciences, East Granby, CT</i>	
Recent Developments in CrossBeam® Technology	18
<i>A. Thesen, H. Hoffmeister, M. Schumann, P. Gnauck, Carl Zeiss SMT Oberkochen, Germany</i>	
Heated-Tip AFM: Applications in Nanocomposite Polymer Membranes and Energetic Materials	20
<i>Jason P. Killgore¹, William King², Kevin Kjoller³ and René M. Overney¹, ¹ U. of Washington, Seattle, WA, ² U. of Illinois at Urbana-Champaign, IL, ³ Anasys Instruments, Santa Barbara, CA</i>	
Automated S/TEM Sample Preparation for Semiconductor Process Support	26
<i>Greg Cuti* and Taha Jabbar**, *Sela USA, Inc. Sunnyvale, CA, and **Athenian Institute, Danville, CA</i>	
Serial Sectioning via Microtomy (or, How To Get Over 100 Consecutive Serial Sections On One TEM Grid)	30
<i>David Elliott, University of Arizona, Tucson, AZ</i>	
A Combined In-situ and Electron Tomography Holder for (S)TEM	34
<i>C. Mitterbauer*, N.D. Browning**, and P. V. Deshmukh***, *U. of California, Davis, CA, **Lawrence Livermore National Lab., CA, ***E. A. Fischione Instruments, Inc., Export, PA</i>	
Infrared Laser Confocal Microscopy: Fast, Flexible, Cost-Effective Inspection and Metrology Tool for Microelectronic Manufacturing	36

<i>David Rideout, Olympus Micro-Imaging Orangeburg, NY</i>	
New Approaches to Managing, Marketing, and Money for Maintaining a Core Facility (<i>D. Sherman, Organizer</i>)	38
Part Ia: Case Study: Strategic plan for an EM Facility	38
<i>Elaine Humphrey</i>	
Part Ib: How to Make a Business Plan for Facility Maintenance and Growth	39
<i>Donald A. Blewett, Purdue University</i>	
A Note on Storing and Testing Gold Conjugates	44
<i>Jan Leunissen, Aurion, Costerweg, The Netherlands</i>	
Cross-sectional TEM Sample Preparation for Nanowires or Porous Films Grown on a Substrate	44
<i>Chengyu Song, NCEM, Lawrence Berkeley National Laboratory</i>	
New & Interesting at Cell Biology and Industry News	46
Netnotes	50
Index of Advertisers	62

ABOUT THE COVER

This is an image of cultured fibroblasts that were subsequently stained with safranin and β X-gal containing ferrocyanide. The sample was imaged using a BX-51 and 40x objective. The microscope was equipped with a CytoViva™ illuminator and a CytoViva Dual Mode Fluorescence™ module, which allowed simultaneous observation of both the fluorescently labeled and unlabeled structures (www.CytoViva.com). The image was captured with a Dage XL digital camera. The samples were provided by Dr. Doug Martin of the Scott-Ritchey Research Center, College of Veterinary Medicine, Auburn University, AL.

COMING EVENTS

2007

- ✓ **Microscopy 2007**
February 5-9, 2007, Auckland, NZ
enquiries@microscopy2007.org.nz
- ✓ **PITTCON 2007**
February 25-March 2, 2007, Chicago, IL
www.pittcon.org
- ✓ **The American Chemical Society**
March 25-29, 2007, Chicago, IL
natlmtg@acs.org
- ✓ **American Soc. for Biochemistry and Molecular Engineering**
April 2007, Washington, DC
www.asbmb.org
- ✓ **Microscopy of Semiconducting Materials' Conf. MSM XV**
April 2-5, 2007, Churchill College, Cambridge
conferences.iop.org/msmxv
- ✓ **SCANNING 2007**
April 10-12, 2007, Monterey, CA
www.scanning.org
- ✓ **7th Internat. ELMI Course On Advanced Light Microscopy**
April 17-20, 2007, The University Of York, UK,
www.york.ac.uk/depts/biol/tf/ELMI/index.htm
- ✓ **GATAN 2007 Training Schools**
April 17-May 3, 2007, Pleasanton, CA (multiple choices)
info@gatan.com
- ✓ **Lehigh Microscopy School**
June 3-15, 2007, Bethlehem, PA (multiple choices)
www.lehigh.edu/microscopy
- ✓ **3D Microscopy of Living Cells (+ pre & post courses)**
June 17-28, 2007, U. of British Columbia, Vancouver, BC
www.3dcourse.ubc.ca
- ✓ **8th Multinational Congress on Microscopy**
June 17-21, 2007, Prague, Czech Republic
8mcm@biomed.cas.cz
- ✓ **34th Annual Mtg. of the Microscopical Society of Canada**
June 18-20, 2007, Alberta, Canada
www.phys.ualberta.ca/MSC-2007/
- ✓ **59th annual INTER/MICRO Conference**
July 9-13, Chicago, IL
www.mcri.org
- ✓ **Microscopy and Microanalysis 2007**
August 5-9, 2007, Fort Lauderdale, FL
mm2007.microscopy.org
- ✓ **The American Society for Cell Biology**
December 1-5, 2007, Washington, DC
www.ascb.org

2008

- ✓ **Microscopy and Microanalysis 2008**
August 3-7, 2008, Albuquerque, NM
www.msa.microscopy.com

2009

- ✓ **Microscopy and Microanalysis 2009**
August 3-6, 2009, Baltimore, MD
www.msa.microscopy.com

Please check the "Calendar of Meetings and Courses" in the MSA journal "Microscopy and Microanalysis" for more details and a much larger listing of meetings and courses.

MICROSCOPY TODAY

The objective of this publication is to provide material of interest and value to working microscopists!

The publication is owned by the Microscopy Society of America (MSA) and is produced six times each year in odd months, alternating with MSA's peer-reviewed, scientific journal *Microscopy and Microanalysis*. We greatly appreciate article and material contributions from our readers—"users" as well as manufacturers/suppliers. The only criterion is that the subject matter be of interest to a reasonable number of working microscopists. *Microscopy Today* has authors from many disparate fields in both biological and materials sciences, each field with its own standards. Therefore *MT* does not have a rigid set of style instructions and encourages authors to use their own style, asking only that the writing be clear, informative, and accurate. Length: typical article length is 1,500 to 2,000 words plus images, longer articles will be considered. Short notes are encouraged for our Microscopy 101 section. See our "Instructions to Authors" document on our website.

MICROSCOPY TODAY

ISSN 1551-9295

Ron Anderson, Editor

randerson20@tampabay.rr.com

Phil Oshel, Technical Editor

oshel1pe@cmich.edu

Thomas E. Phillips, Contributing Editor

PhillipsT@missouri.edu

Dale Anderson, Art Director

microscopytoday@tampabay.rr.com

Renée Stratmoen, Advertising Director

oshel1pe@cmich.edu

Regular Mail to:

Microscopy Today, P.O. Box 247, Largo, FL 33779

Courier Mail to:

1001 Starkey Road, Lot #374, Largo, FL 33771

Telephones:

1-(727)507-7101 • Fax: (727)507-7102 • Cell: (727) 631-1022

e-Mail:

microscopytoday@tampabay.rr.com

www Page:

http://www.microscopy-today.com

Colophon: *Microscopy Today* is created using components of Adobe Creative Suite CS2*

Total Circulation: 14,613

Disclaimer: By submitting a manuscript to *Microscopy Today*, the author warrants that the article is original (or that the author has the right to use any material copyrighted by others). The use of trade names, trademarks, etc., does not imply that these names lack protection by relevant laws and regulations. *Microscopy Today*, the Microscopy Society of America, and any other societies stated, cannot be held responsible for opinions, errors, or for any consequences arising from the use of information contained in *Microscopy Today*. The appearance of advertising in *Microscopy Today* does not constitute an endorsement or approval by the Microscopy Society of America of the quality or value of the products advertised or any of the claims, data, conclusions, recommendations, procedures, results or any information found in the advertisements. While the contents of this magazine are believed to be accurate at press time, neither the Microscopy Society of America, the editors, nor the authors can accept legal responsibility for errors or omissions.

© Copyright, 2007, The Microscopy Society of America. All rights reserved.

11 MEGAPIXELS

High Definition Digital TEM Cameras
AMT's HOT NEW LINE

**TEM
INTEGRATION**

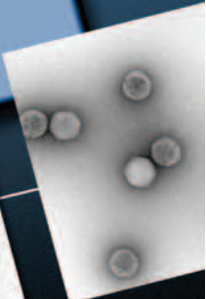
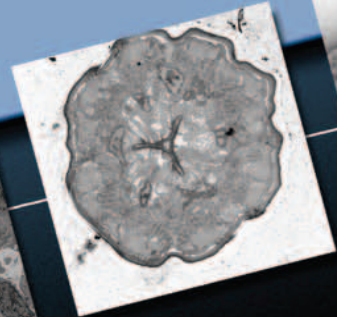
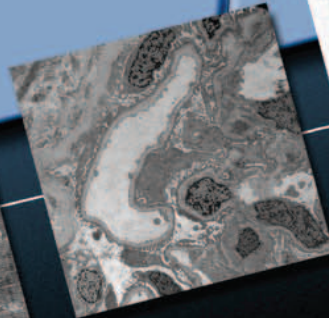
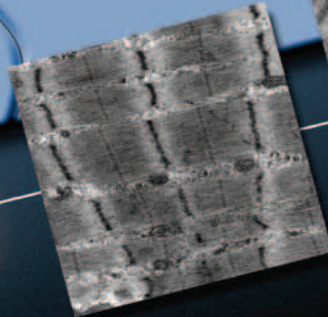
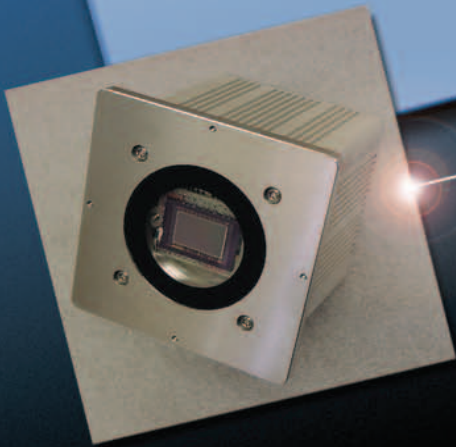
**FASTEST
DISPLAY**

**LARGEST FIELD
OF VIEW**

**BUILT-IN
RELIABILITY**

**PROVEN
SUPPORT**

**SIDE MOUNT
& BOTTOM MOUNT**



Advanced Microscopy Techniques Corporation
3 Electronics Avenue • Danvers, MA 01923
978-774-5550 • www.amtimaging.com