Development of a methodology for evaluating the internal porosity of hair through scanning electron microscopy images

Angela Cristina Vargas Calle*[1], Viviane Albarici[1], Cristina Moreira de Souza[1], Adriano Pinheiro[1].

Grupo kosmo science

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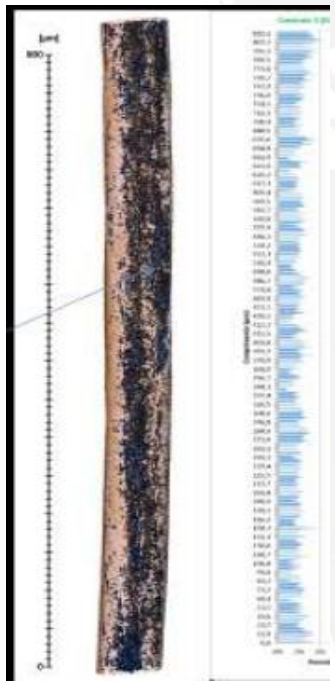
Motivation

EXISTENT ROUTES EXPENSIVE OR INACCESSIBLE

BET

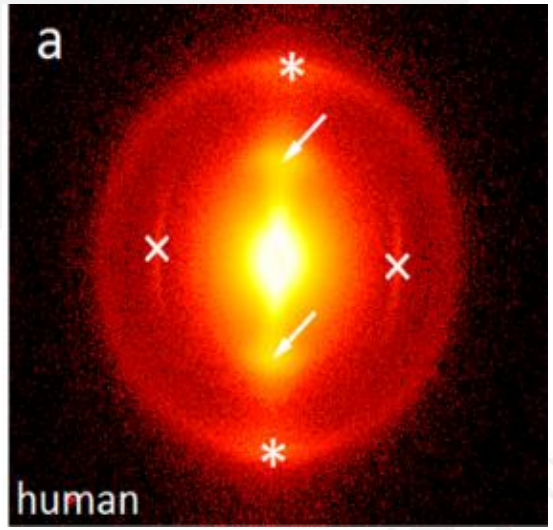
Kaushik et al. 2021

X - RAY Microtomography



Scanavez et al. 2018

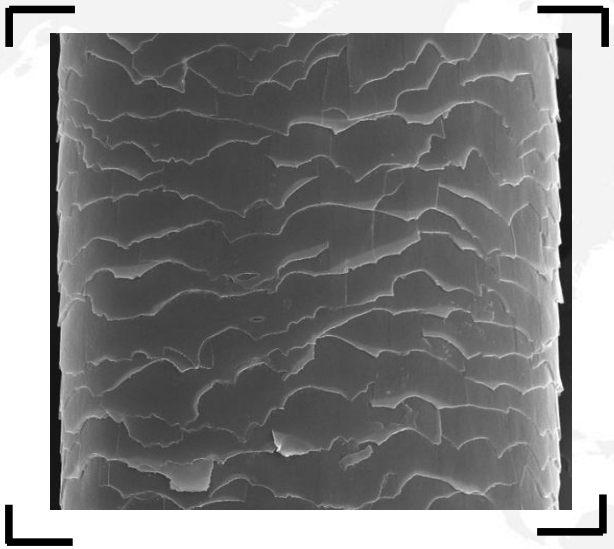
SAXS / XRD

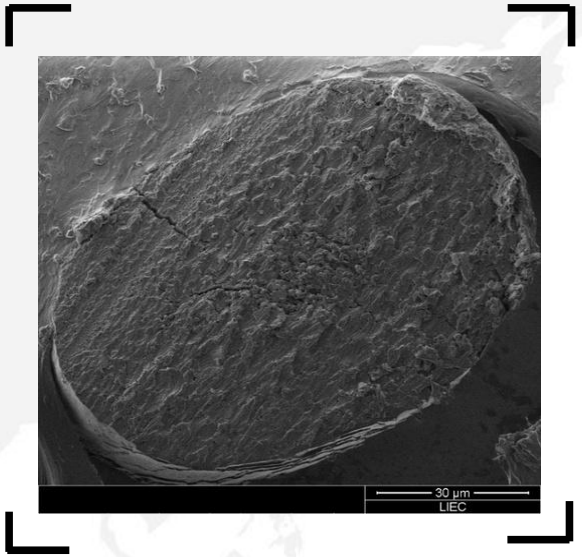


Mülner et al. 2020

Brenner et al. 1995

Motivation





PREVIOUS EXPERIENCE

EVALUATION OF SURFACE DAMAGES

Methodology

PHASE 1

Glass

Tungsten

Tungsten

Stainless Steel

Historesin

Epoxy

Polyester

O.C.T compound

PHASE 2

2 Different days

Natural Hair	Double Bleached Hair		
			
SLES 10%	SLES 10%	Hair Mask	Leave-in

Results of phase 1

PHASE 1

6, 8 and 10µm

~~Glass~~

~~Tungsten~~

Tungsten

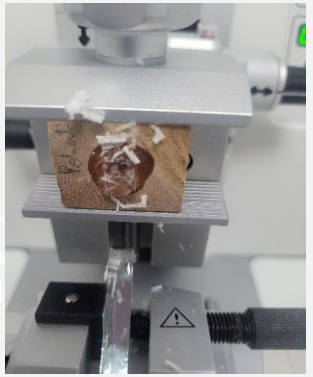
Stainless Steel

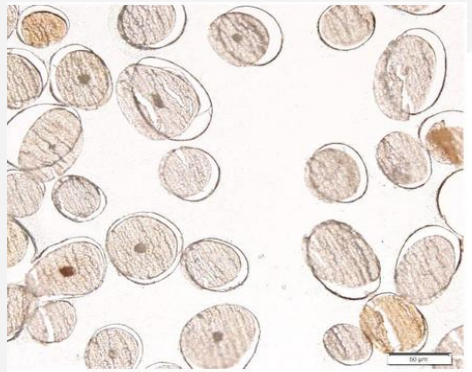
~~Historesin~~

~~Epoxy~~

~~Polyester~~

O.C.T compound





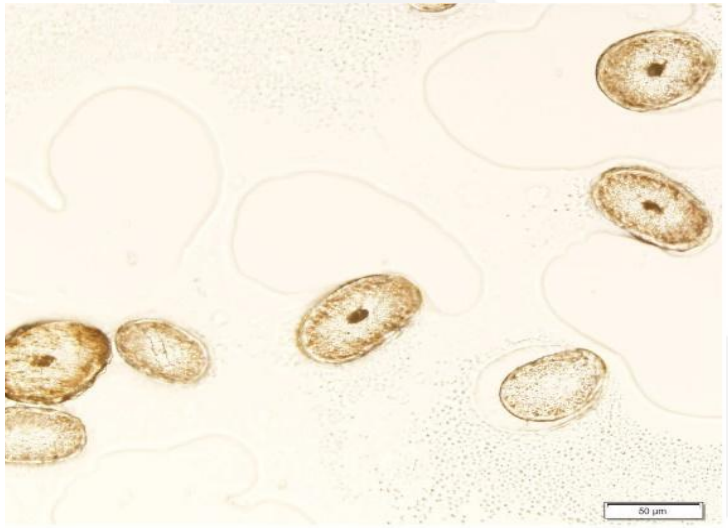
Cuts were made to a thickness of 8µm using a cryostat at a temperature of -30°C and sections were placed on a glass slide.

Results of phase 1

Tungsten

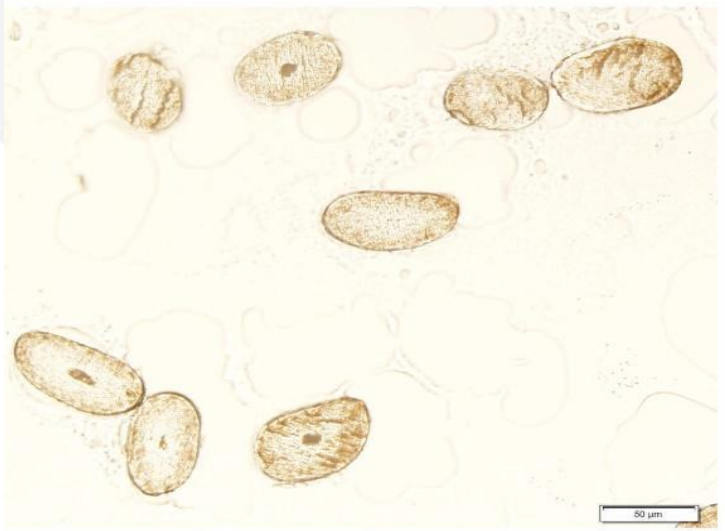
O.C.T Compound

10µm



8µm

6µm

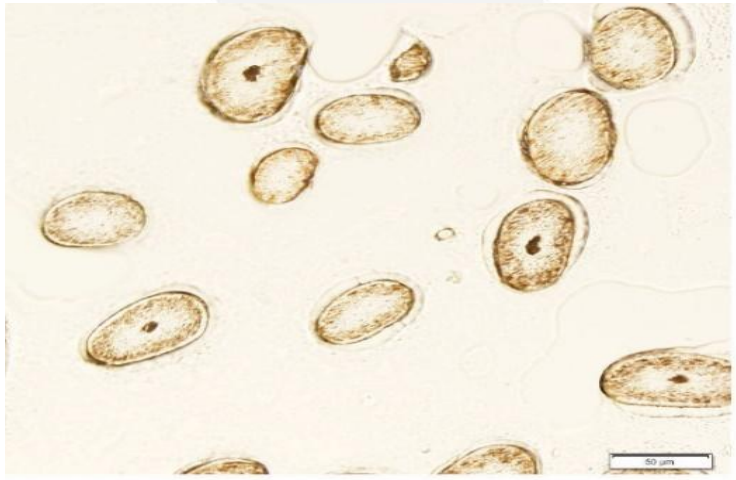


Results of phase 1

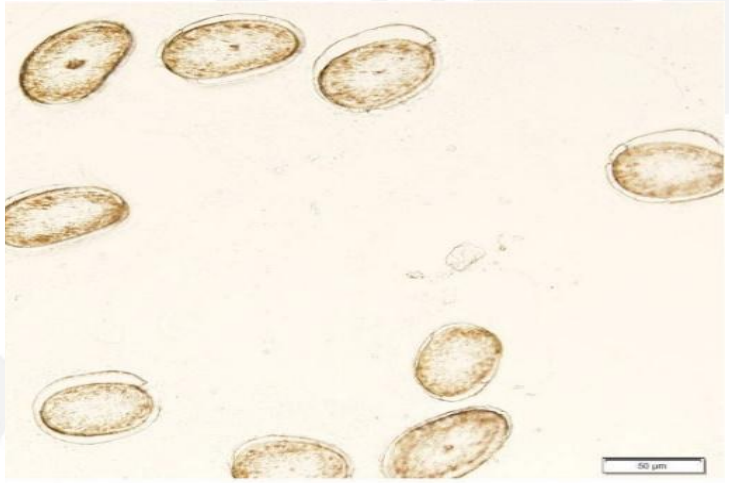
Stainless Steel

O.C.T Compound

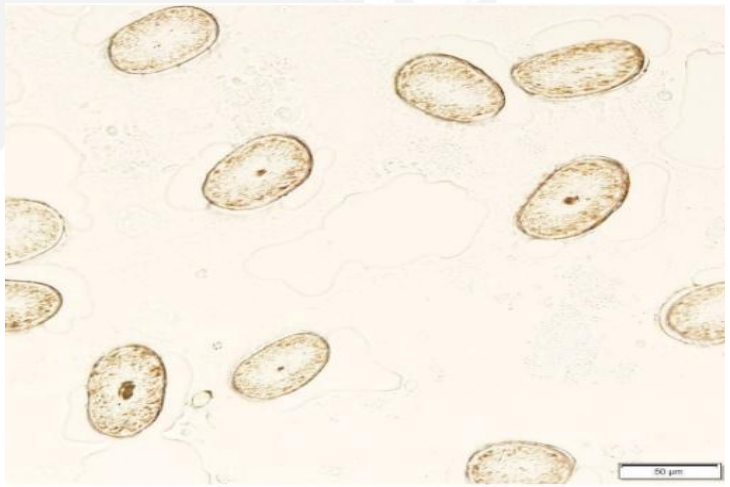
10µm



8µm



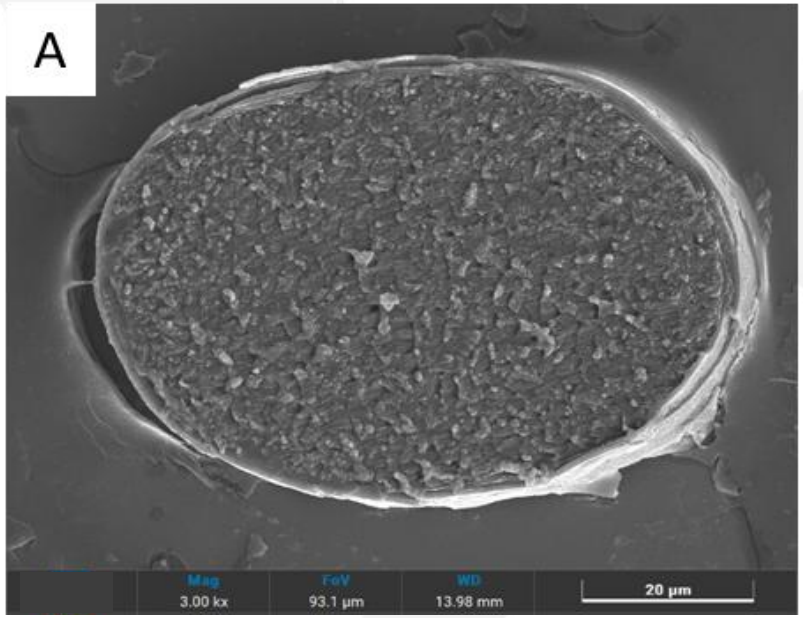
6µm

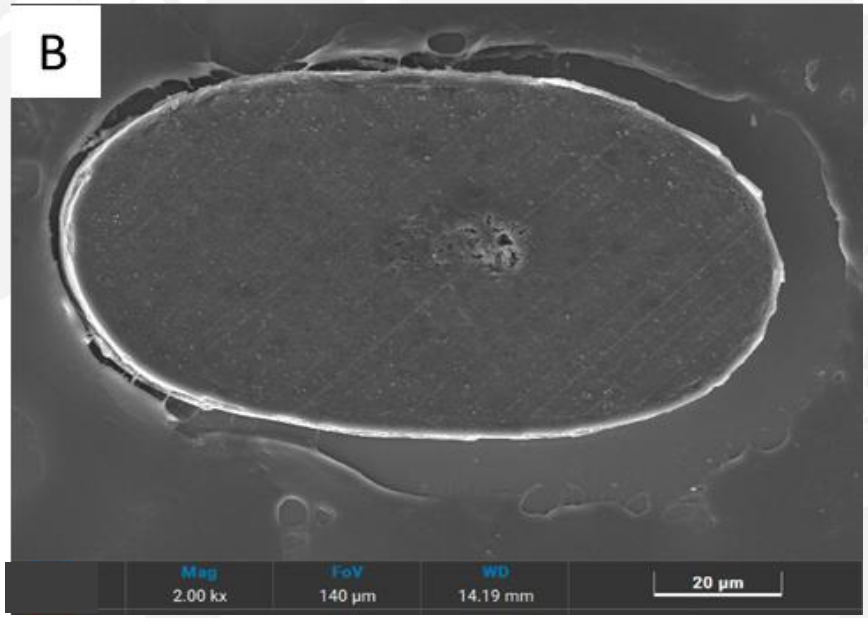


Results of phase 1

Tungsten vs Stainless Steel

O.C.T Compound



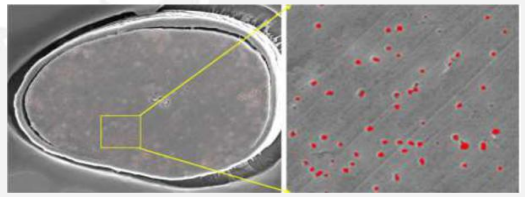


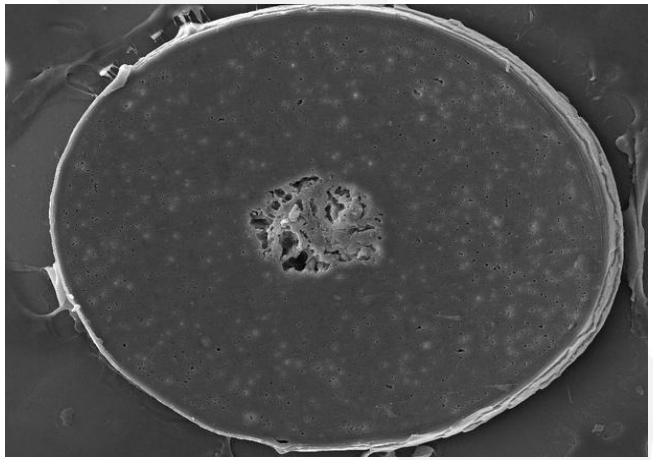
Tungsten

Stainless Steel

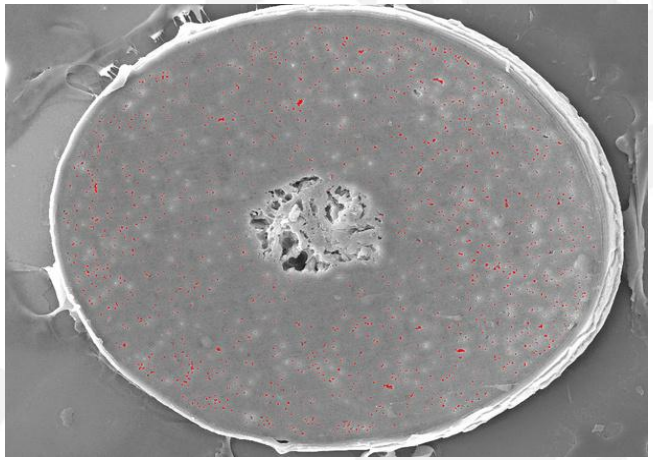
Results of phase 2 - software

Fiji Image J → Labkit MorphoLibJ →

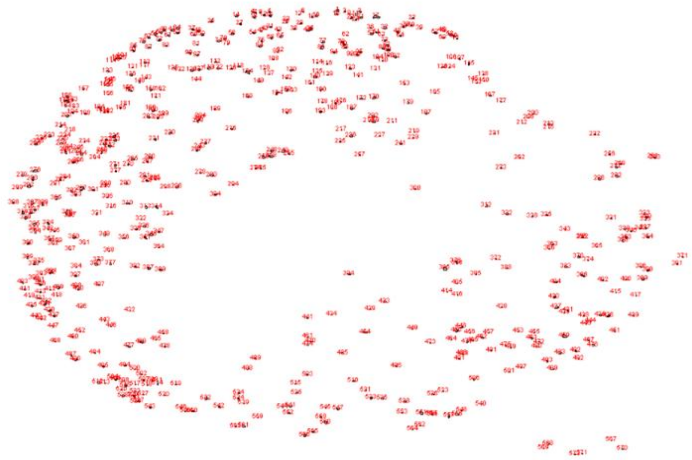




Original Image



Treated Image



Count of Porous

Results of phase 2 - Validation

Reproducibility

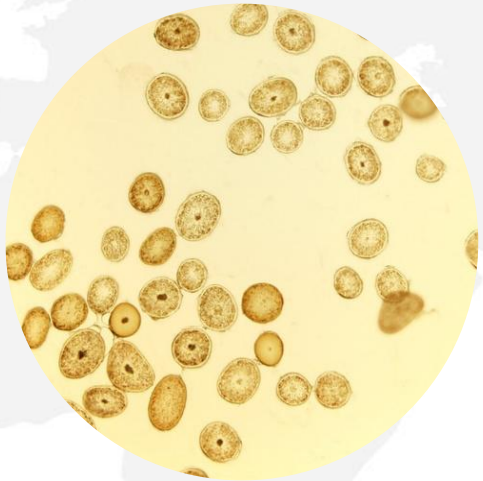
2 Different days

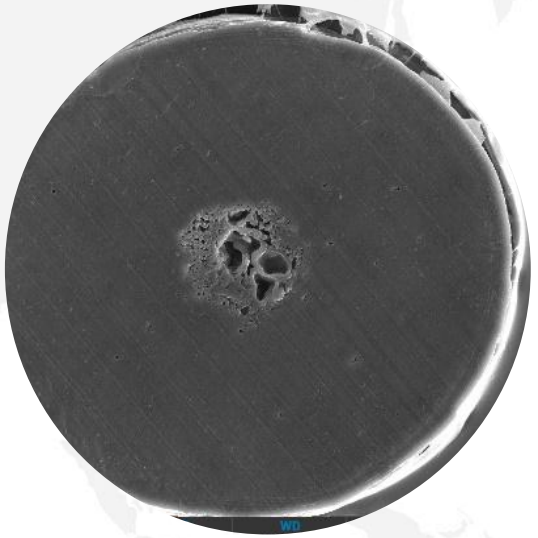
Natural Hair **Double Bleached Hair**

SLES 10% **SLES 10%** **Hair Mask** **Leave-in**

Differentiation

•The hair fibers were embedded in Tissue-Tek resin polymerized at -80°C for 5 minutes.



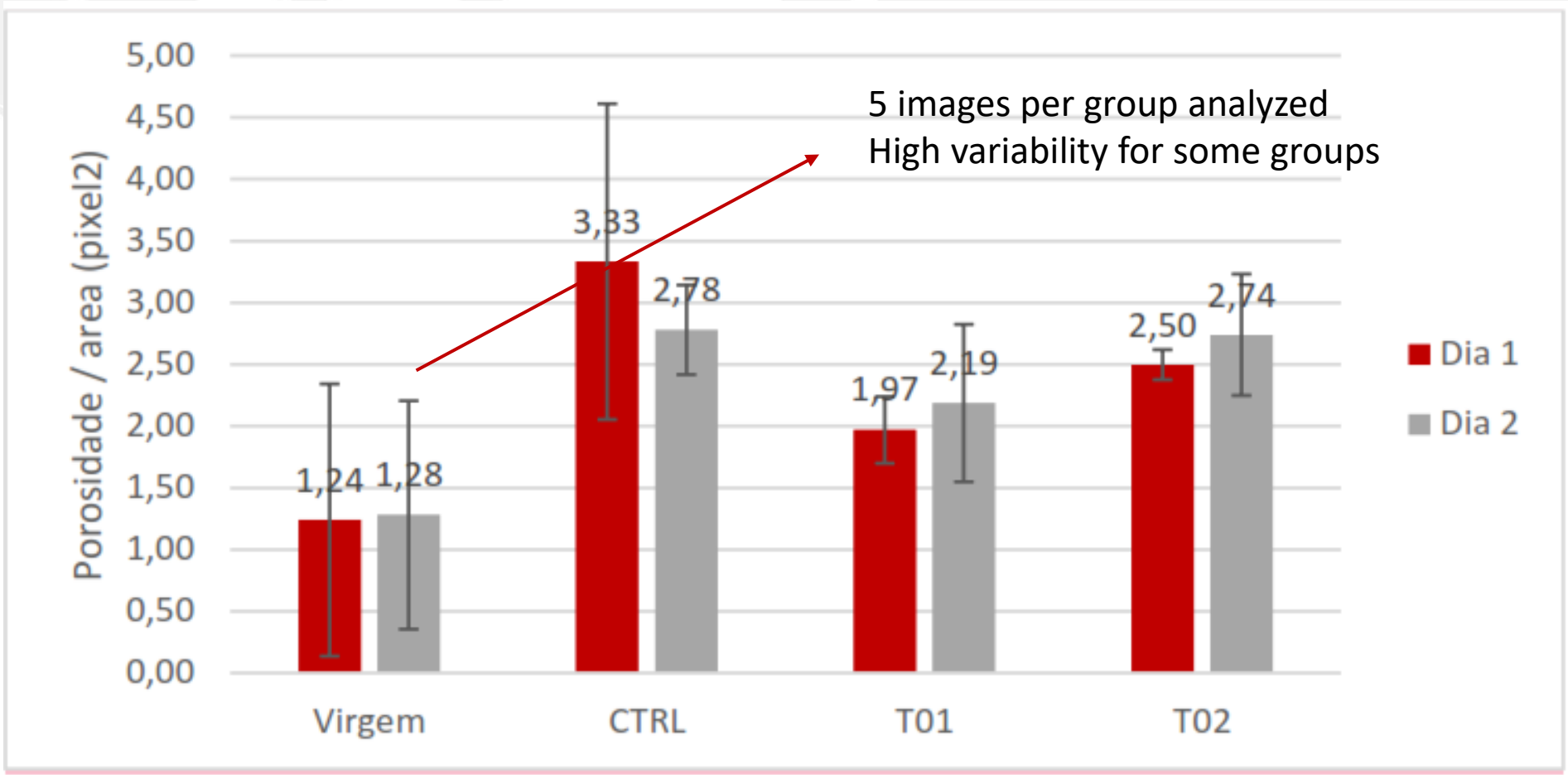


5 Hair fibers are collected randomly

The segments are fixes to microscope Holder and covered with a conductive gold layer

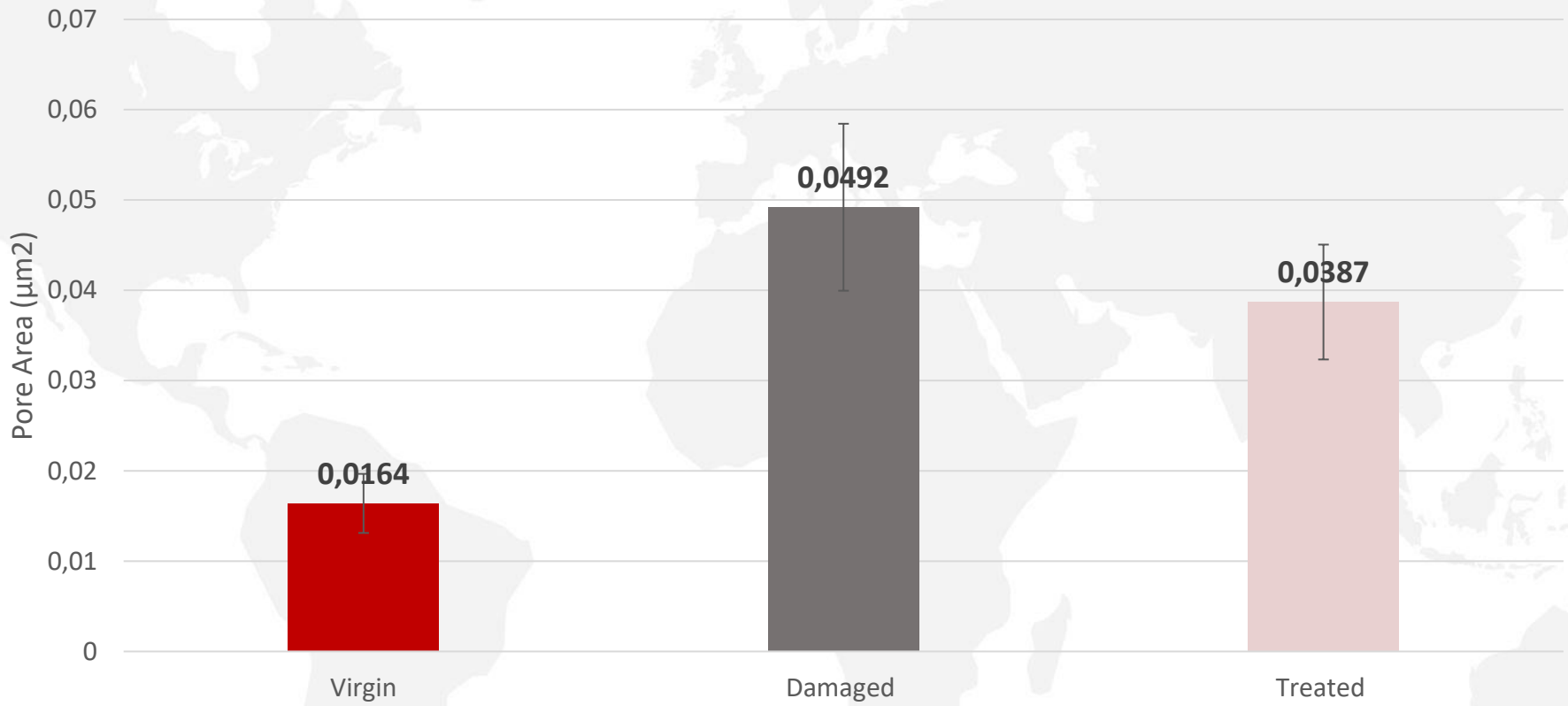
Results of phase 2 - Validation

The pore area, PA in the cross-section of the fiber was quantified using the “pixel area2” - The smaller the average pore area, the greater the repairing potential of the cosmetic product.



Increasing sample size

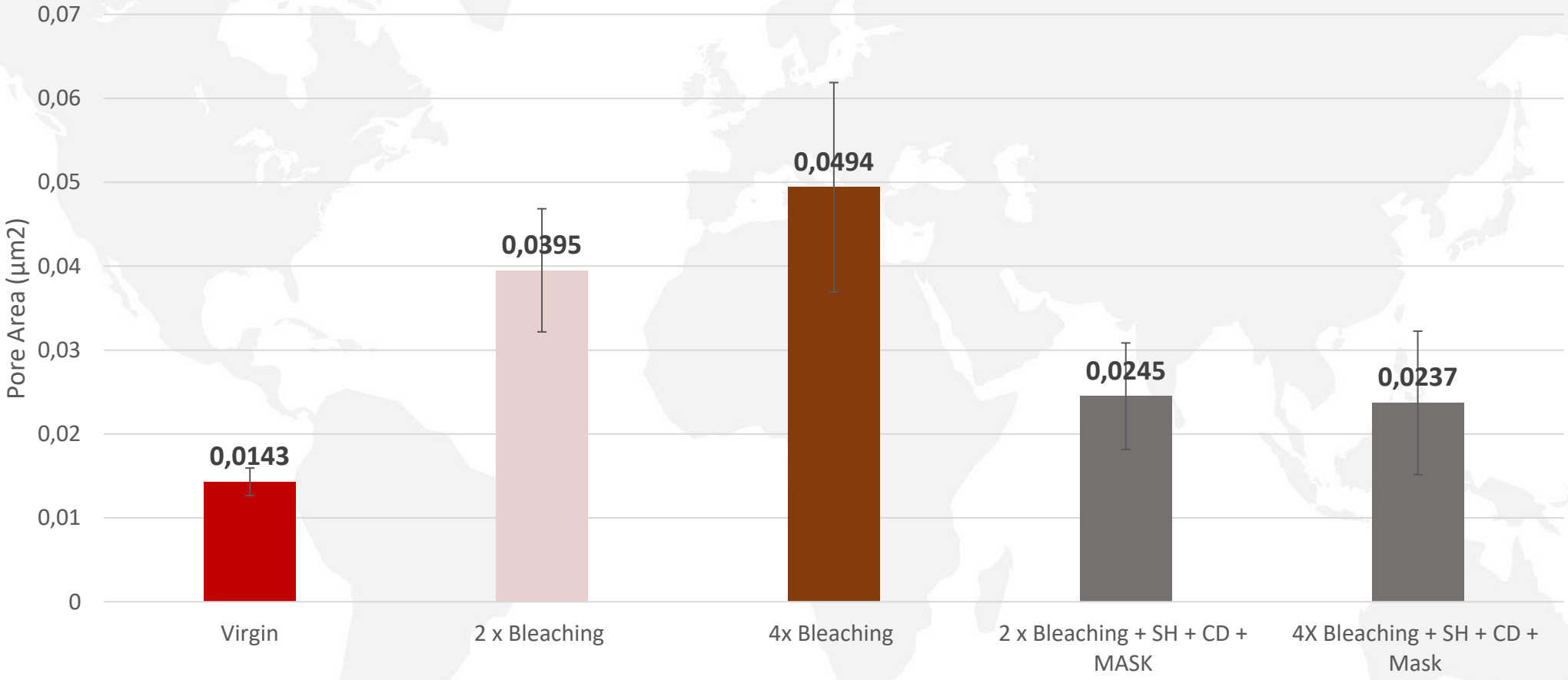
1- Increase the number of images to 10 per group → Result in a lower standard deviation



Different colors means statistically significant diferences

New Analysis

2 - New experiment including hair with different damage levels



Different colors means statistically significant diferences

Summary

- Existing techniques for directly measuring hair porosity are expensive and/or difficult to access, especially for small companies seeking to enter the cosmetics market with innovative claims. In this context, scanning electron microscopy emerges as a more accessible and cost-effective alternative.

- To obtain reliable results, it is necessary to produce precise cross-sections without damaging the internal structure of the hair fiber. Among the combinations tested, the best results were achieved using O.C.T. compound as the embedding medium and a stainless steel blade in the cryotome.

- The methodology made it possible to differentiate hair treated with different cosmetic products. However, when only 5 images were analyzed, the standard deviation remained high, indicating the need for a larger sample size. With 10 images, the deviation was reduced, improving the differentiation between the groups.

- One limitation of the methodology is the assumption that hair porosity is homogeneous along the entire hair strand.

Acknowledgement

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BRASIL
Rua Itália, 274 - Jardim Ribeiro - Valinhos /SP
comercial@kosmoscience.com

+ 55 11 | 4369-4984 | + 55 19 | 99599-8815

CONTACTS

TECHNICAL

HAIR STUDIES	angela@kosmoscience.com

SALES TEAM

FRANCE (Europe)	anacesconetto@kosmoscience.com (Business Director) leslie@kosmoscience.com (Technical)
LATAM	paulina@kosmoscience.com (Business Director) leonardo@kosmoscience.com (Business Manager) martha@kosmoscience.com (Business Manager)
NORTH AMERICA	anacesconetto@kosmoscience.com (Business Director) luismisso@kosmoscience.com (Business Manager)

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