



# Science et Beauté de la peau et des cheveux: *Le test vérité de la bio-tribologie*

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UMR 5513 - Ecole Centrale de Lyon – 69 ECULLY

# La Tribologie ?

*Tribologie* du grec «*Tribein*» : **Science du frottement et de l'usure**

**Une science pluridisciplinaire**

**Ingénierie du vivant:**

Vieillesse cutané

Santé

Cosmétique

Cheveux

Ongles



*Aérospatiale*



*Automobile*



*Sport*

**Métrologie sensorielle:**

Peau/cheveux/pelage

Habillement

Luxe



*Archéologie*



*Agroalimentaire*





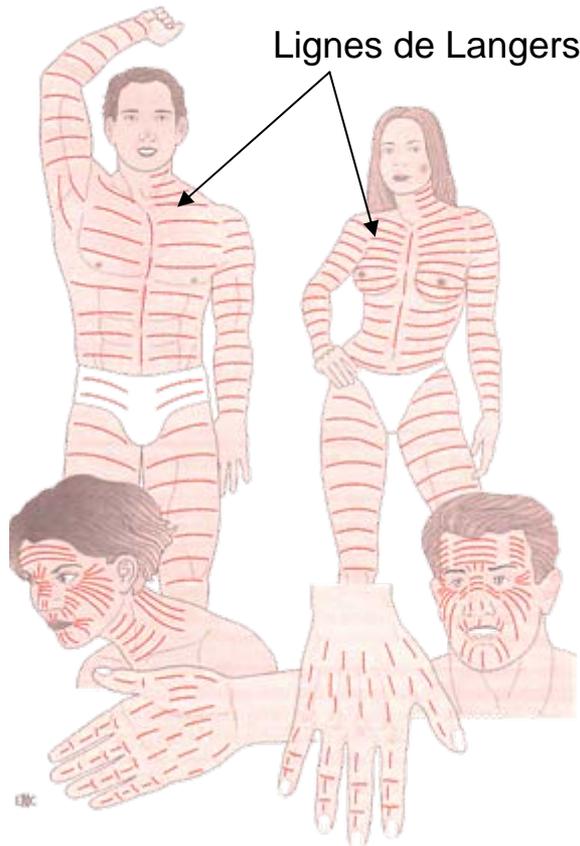
# Pourquoi ma peau n'est pas lisse ?



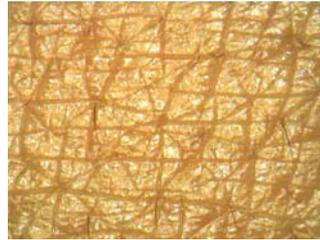
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# Le relief de ma peau

## Lignes de tension mécanique de la peau



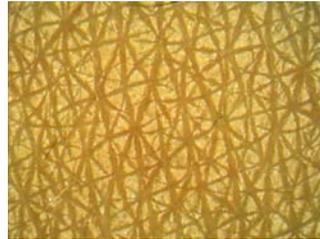
*Front*



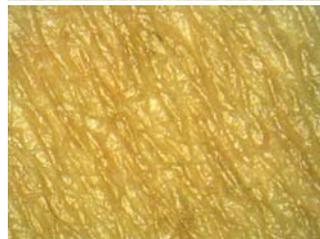
*Joue*



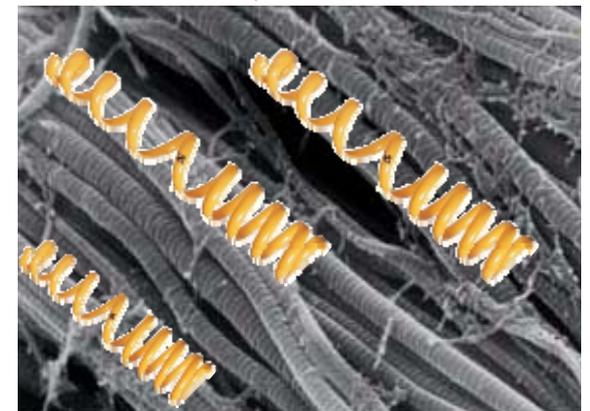
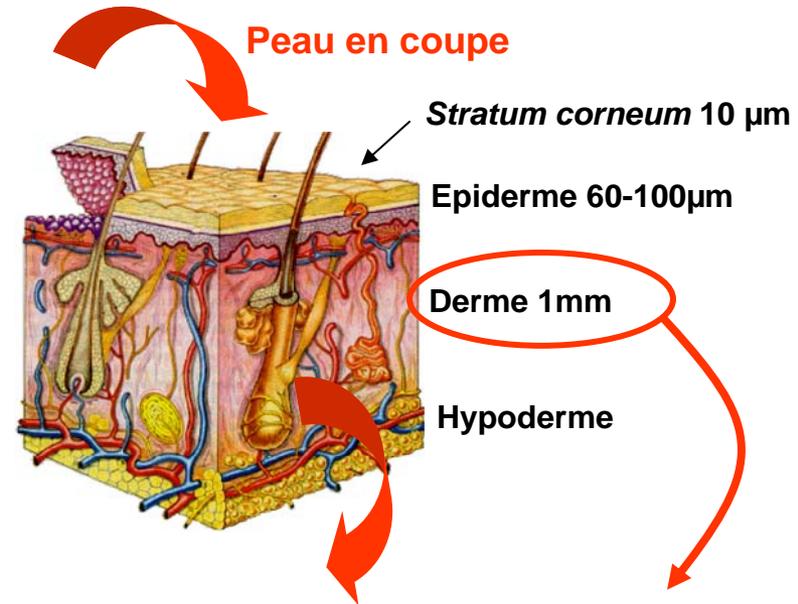
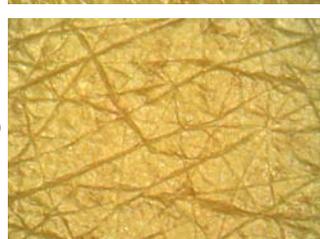
*Avant bras*



*Buste*



*Cheville*

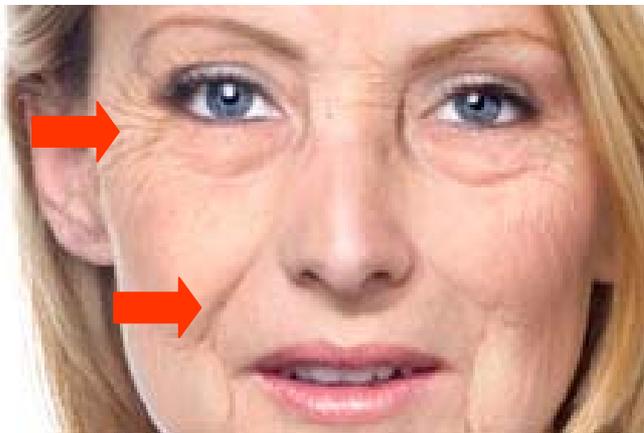


**Fibres élastiques: collagène et élastine**

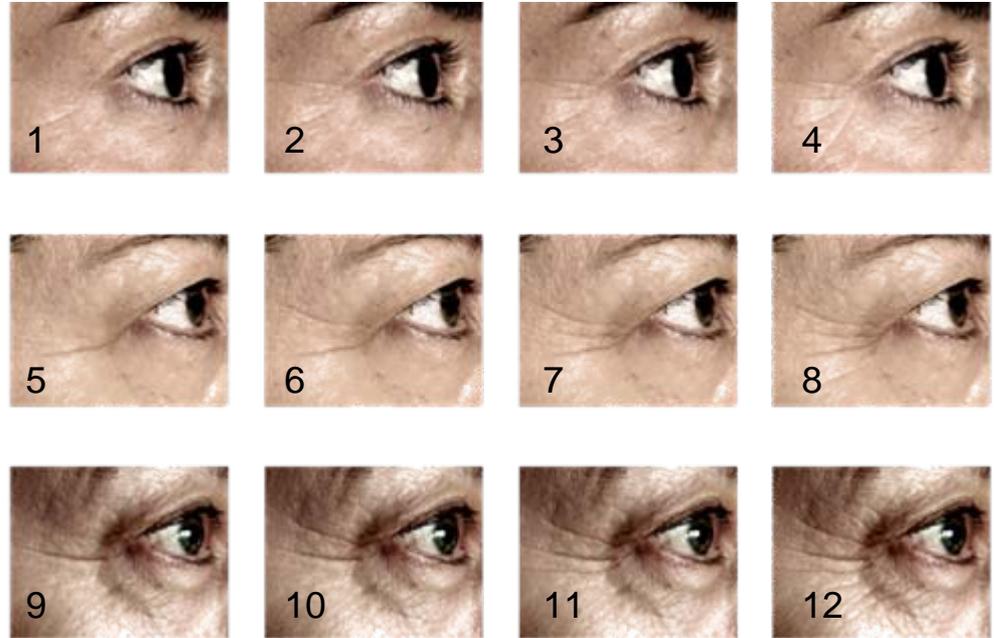
# Le vieillissement cutané



*Visage personne jeune*



*Visage personne âgée*



*Evolution de la ride de la patte d'oie en fonction de l'âge*



*Evolution de la ride du sillon nasogénien en fonction de l'âge*

# Mesurer le relief de la peau

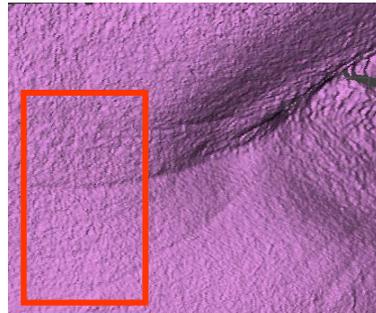
- Mesure *in vivo* par projection de franges



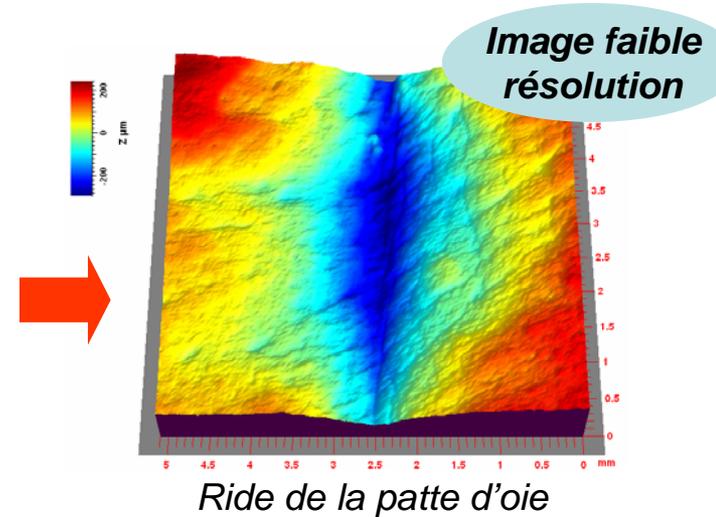
Mise en place du sujet



Projection de franges



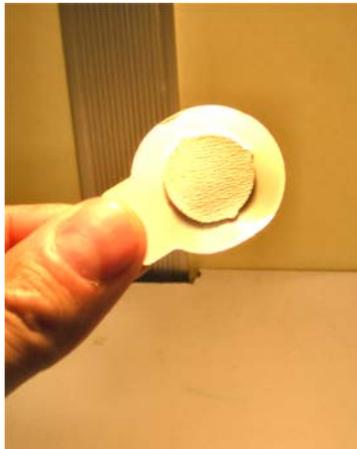
Mesure de la ride



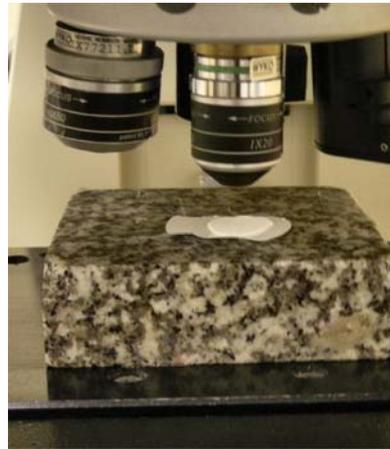
- Mesure par prise d'empreinte



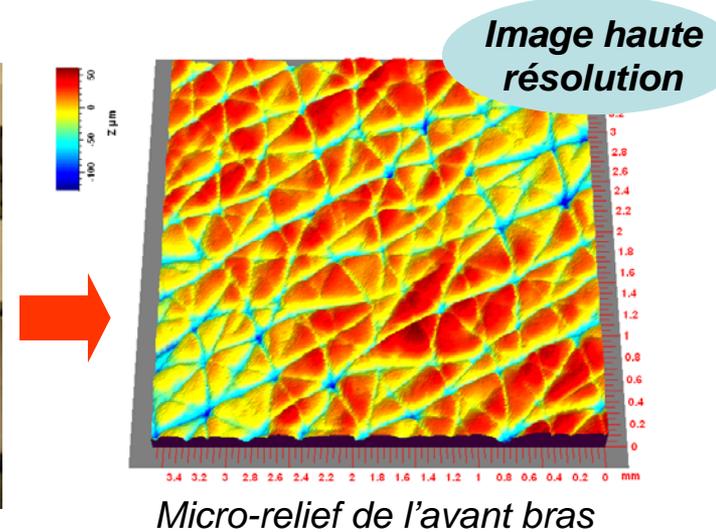
Réalisation d'une empreinte



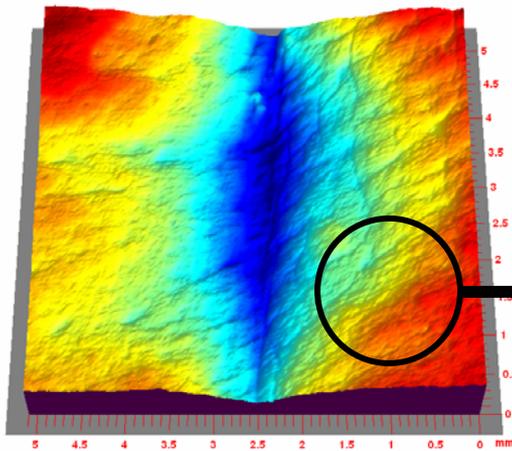
Empreinte en silicone



Mesure par microscopie haute résolution



# Les échelles du relief de la peau

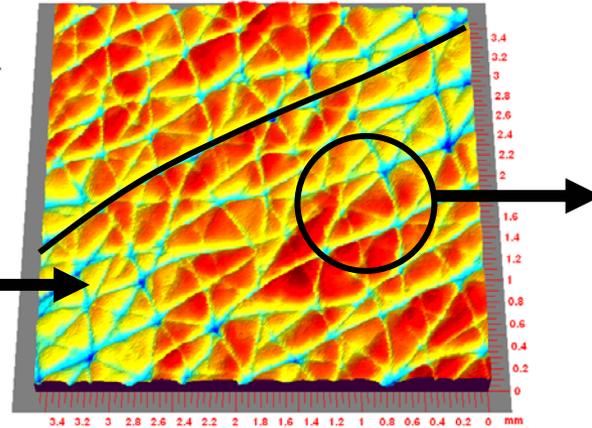


## Rides

Profondeur > 1mm

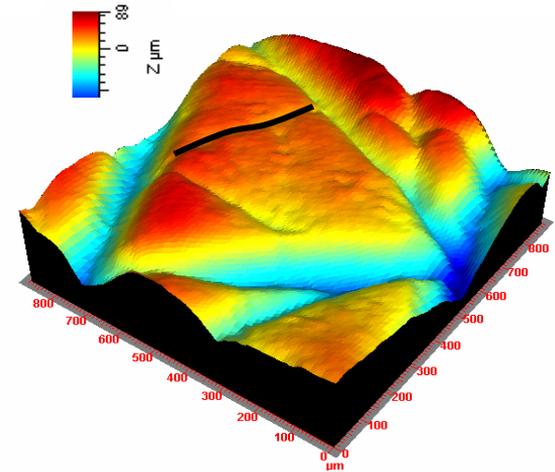
## Ridules

Profondeur 0,2 à 1mm



## Sillons primaires

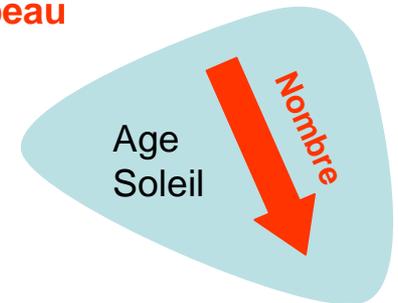
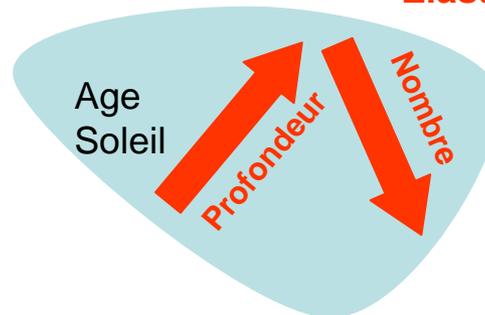
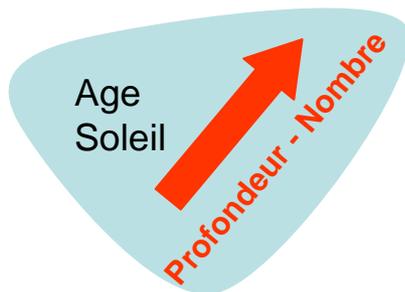
Profondeur 40 à 100 μm



## Sillons secondaires

Profondeur < 40 μm

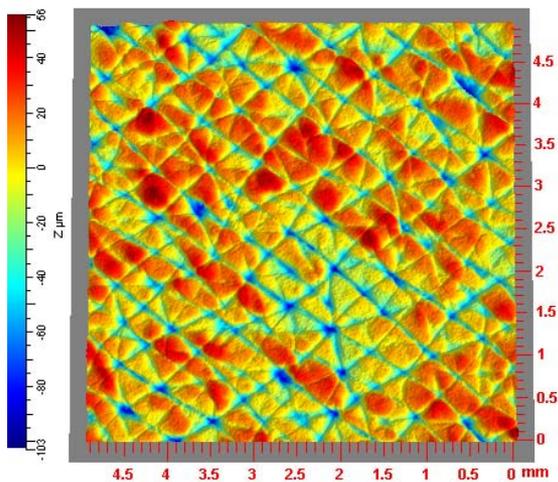
## Elasticité de la peau



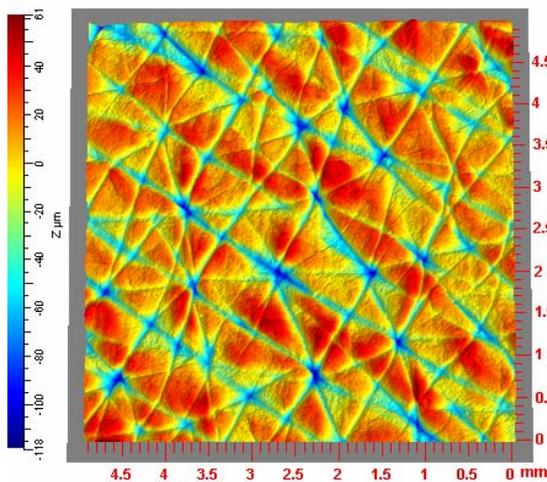
Le relief cutané est l'image de l'état mécanique de la peau

# Evolution de la peau avec l'âge

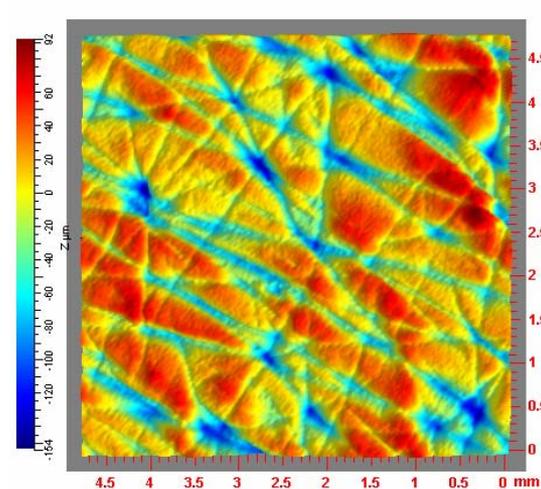
30 -> 40 ans



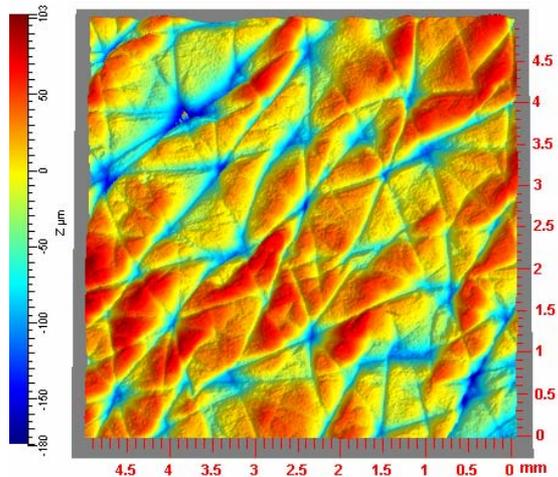
41 -> 50 ans



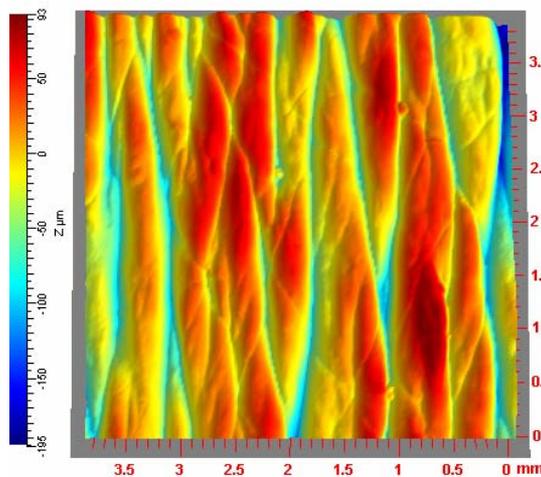
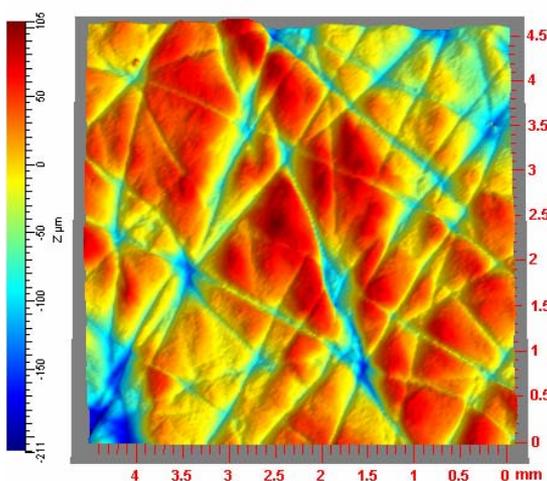
51 -> 60 ans



61 -> 70 ans



> 71 ans

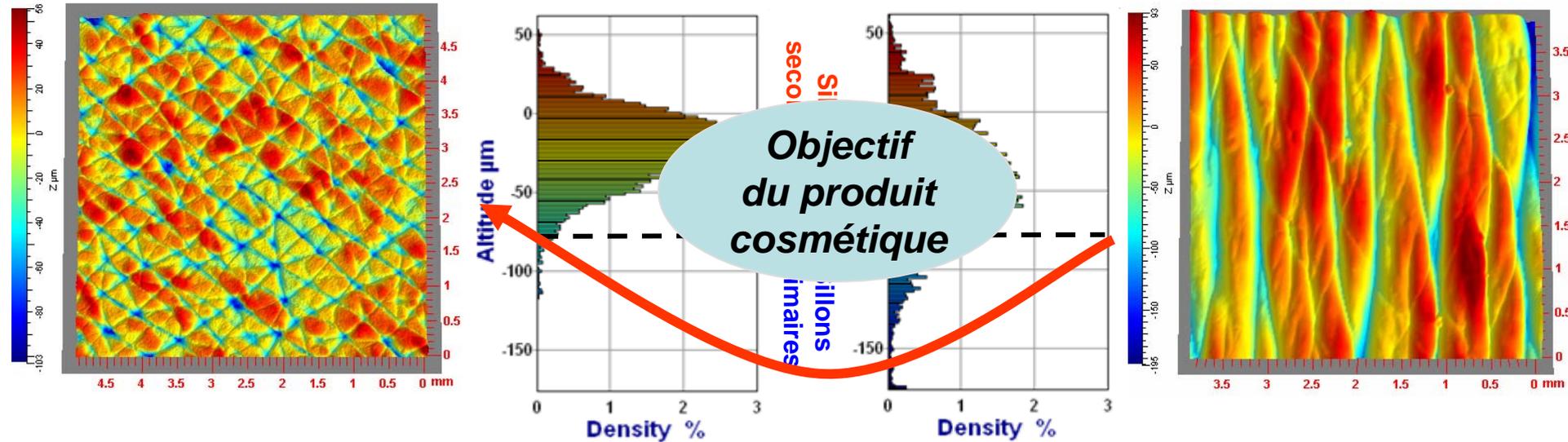


# Evaluation du vieillissement cutané

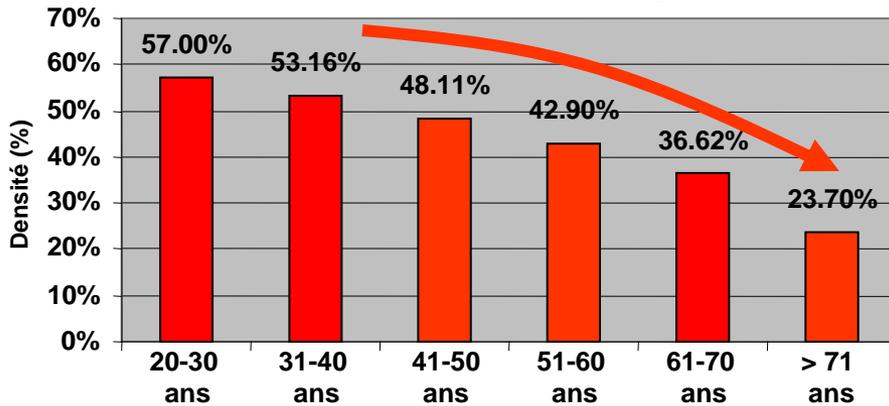
30 -> 40 ans

> 71 ans

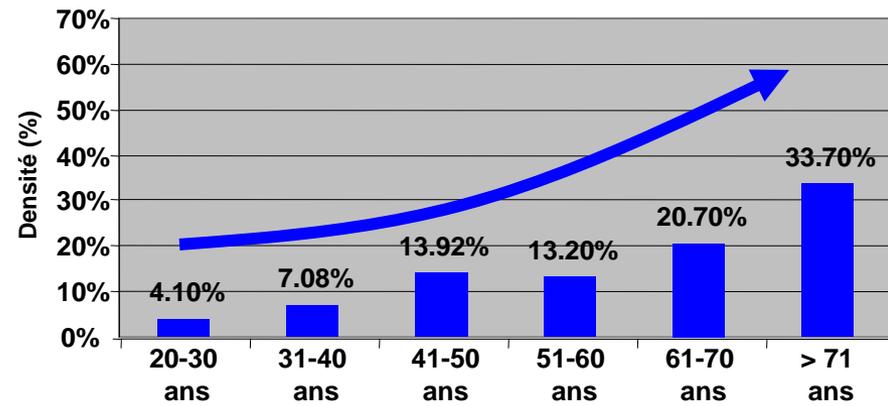
**Objectif  
du produit  
cosmétique**

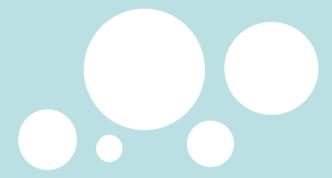


**Densité des sillons secondaires  
Profondeur < 40 µm**



**Densité des sillons primaires  
Profondeur > 40 µm**





# L'efficacité d'un cosmétique sur ma peau ?



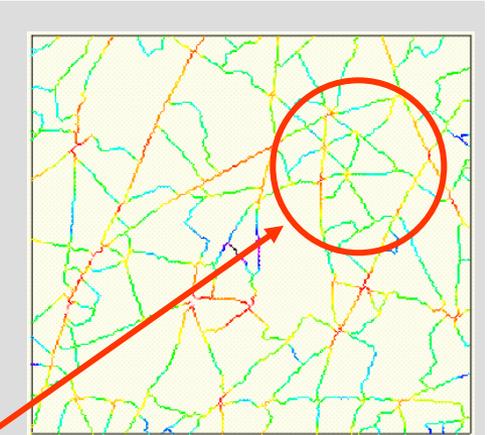
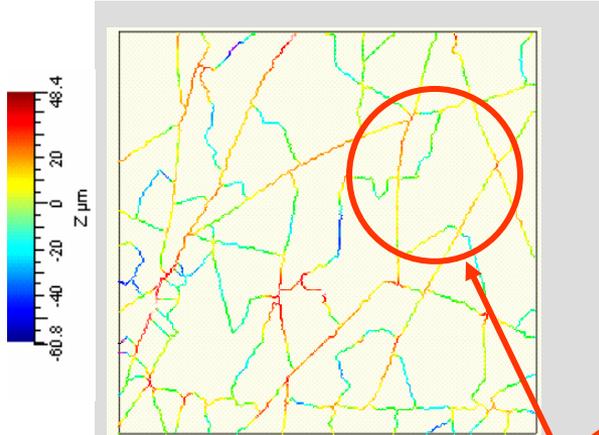
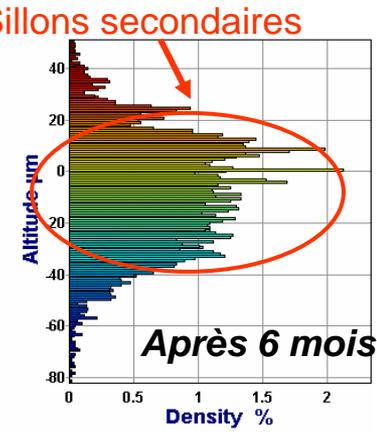
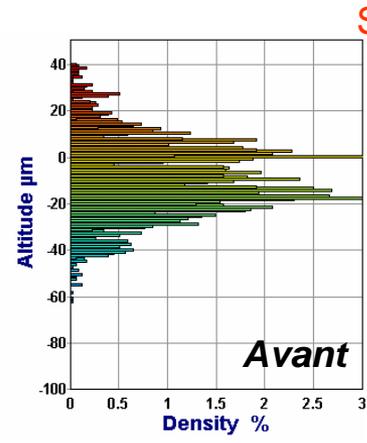
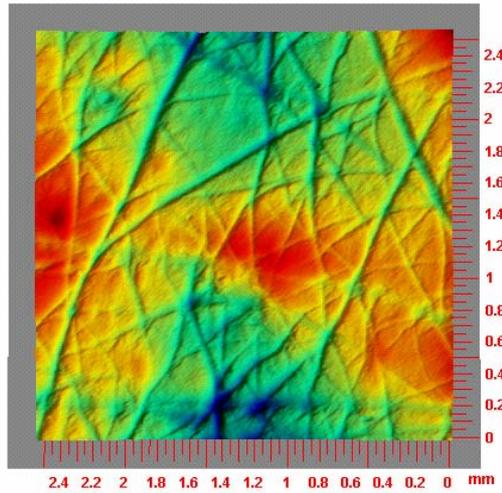
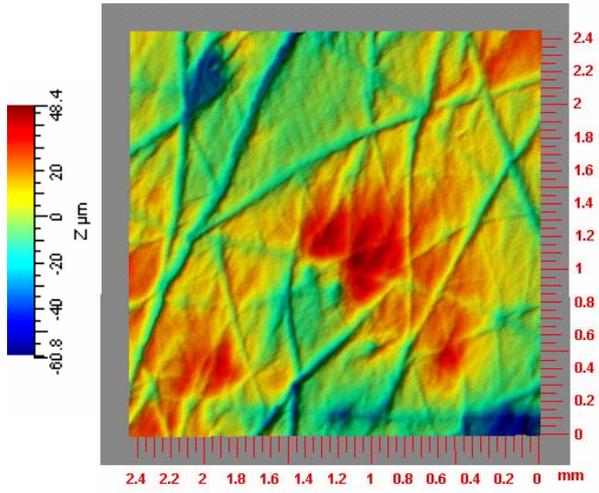
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# Traitement anti-âge

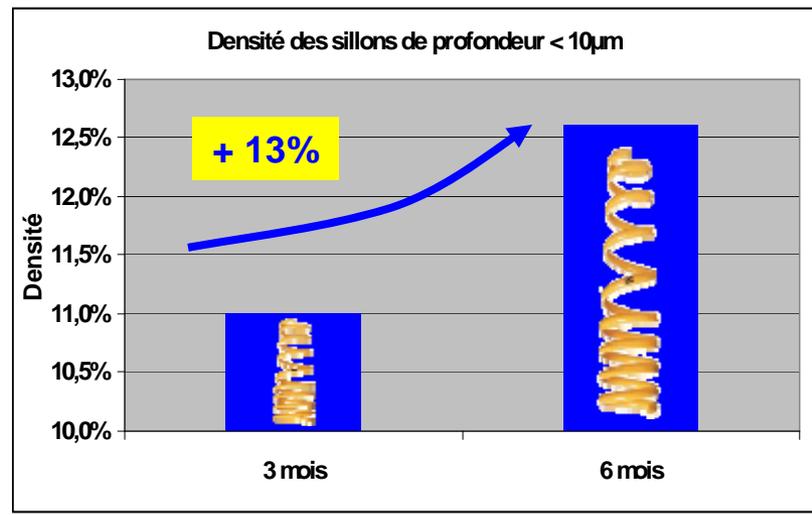
Avant

Après 6 mois

Densité des sillons



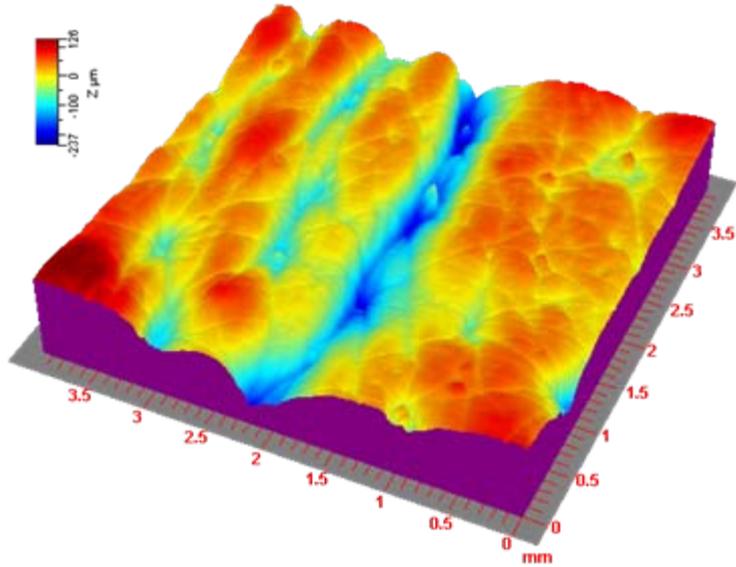
Restructuration du micro-relief



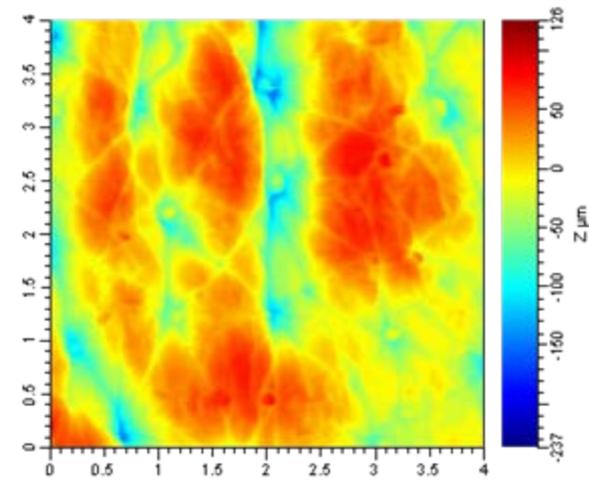
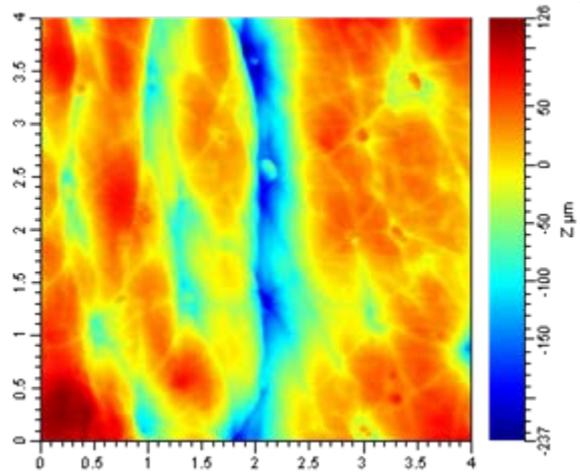
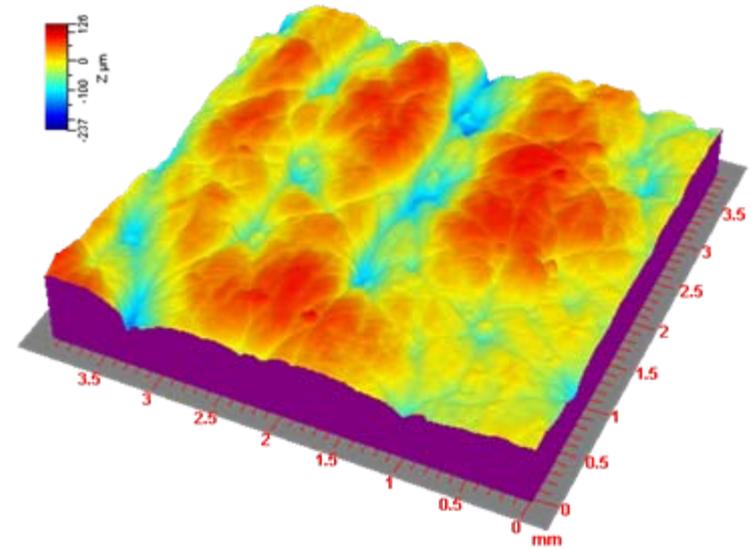
# Traitement anti-rides



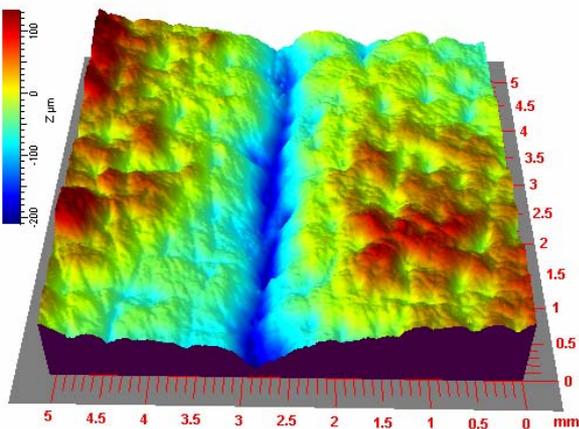
AVANT



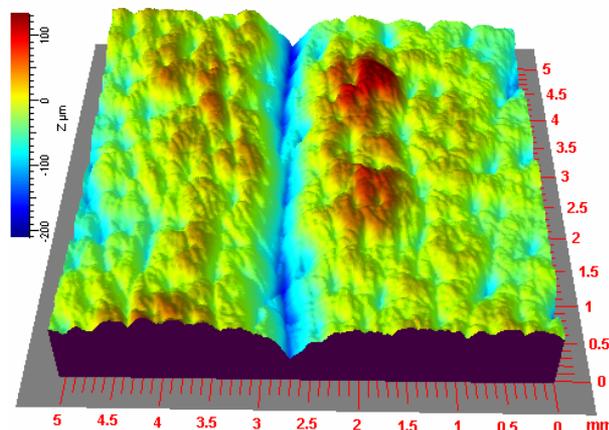
APRES 29 JOURS



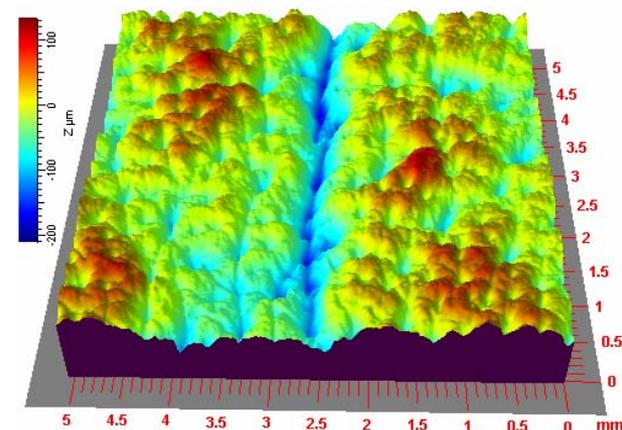
Avant



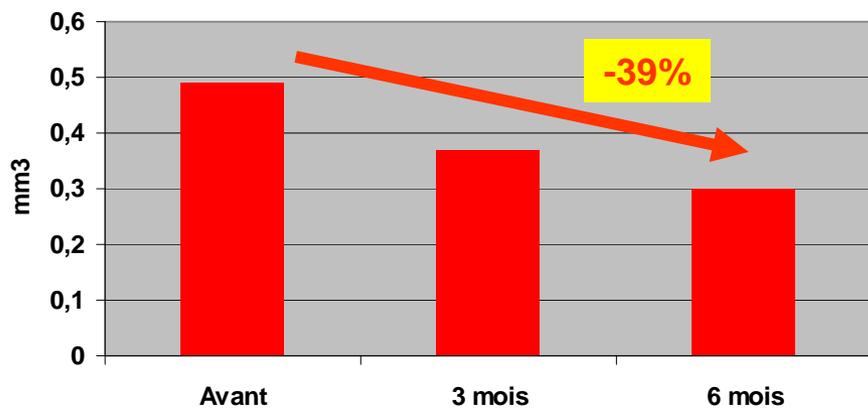
Après 3 mois



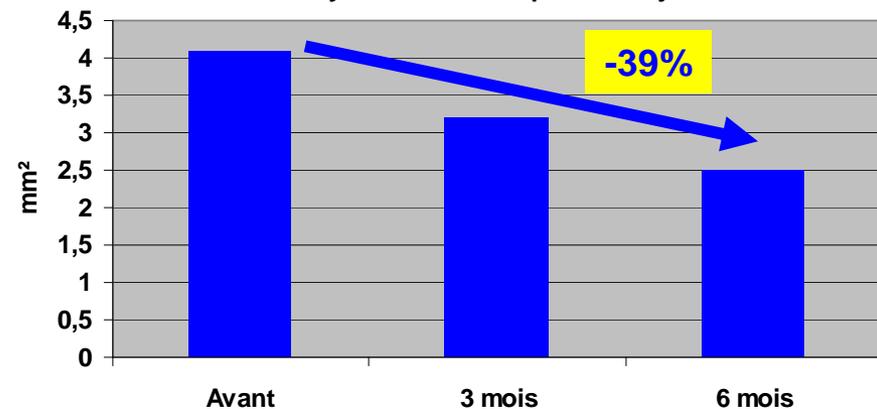
Après 6 mois



Volume moyen de la ride pour 30 sujets



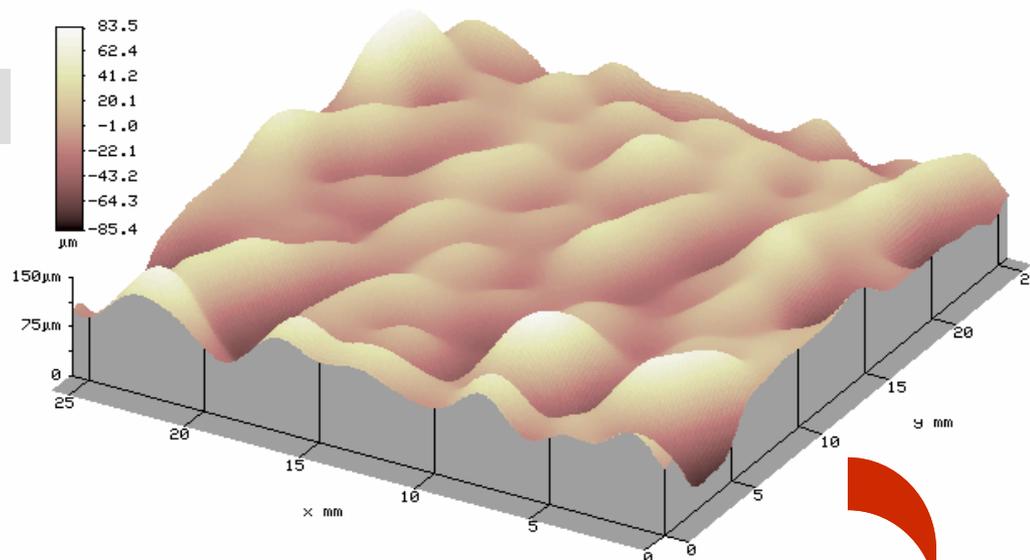
Surface moyenne de la ride pour 30 sujets



# Traitement anti-cellulite

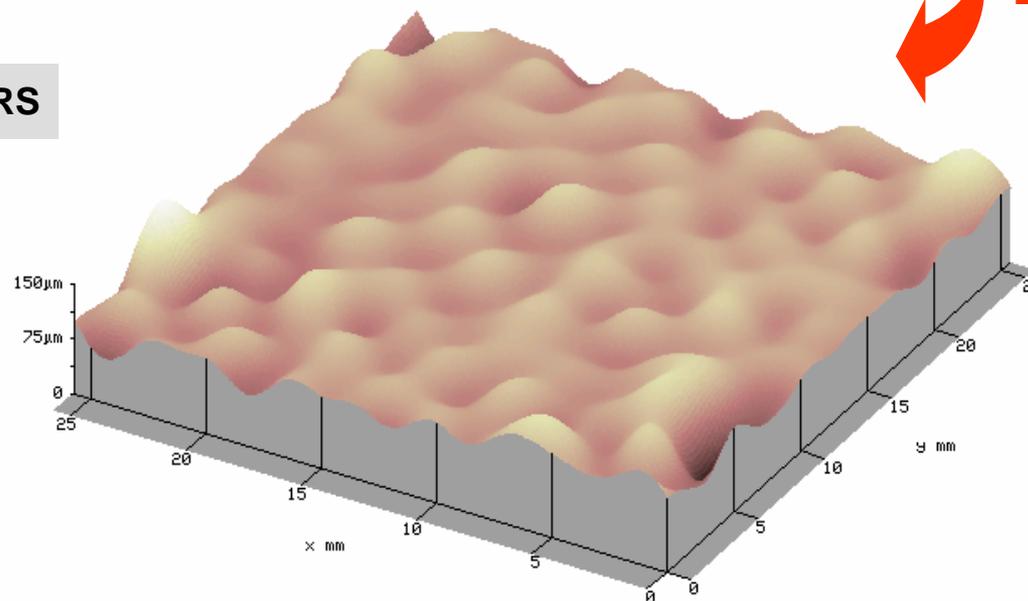


CAPITONS AVANT

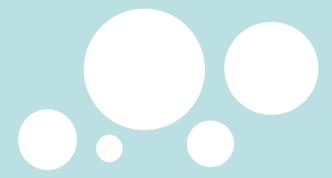


- 17 %  
D'ONDULATION

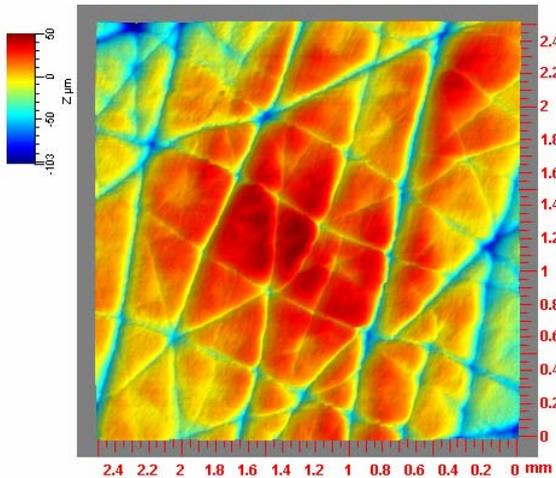
CAPITONS APRES 28 JOURS



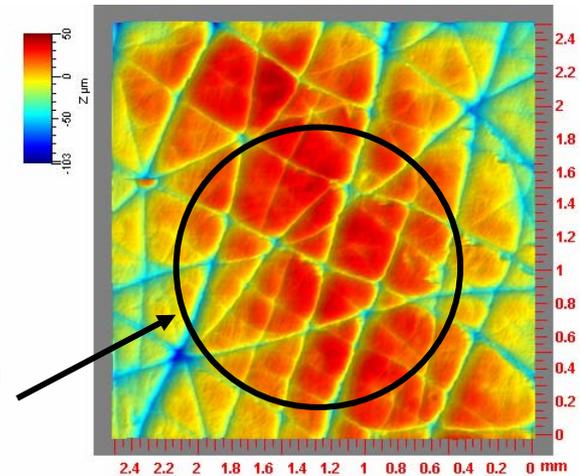
# Traitement cure thermique « peau brûlée »



Avant cure



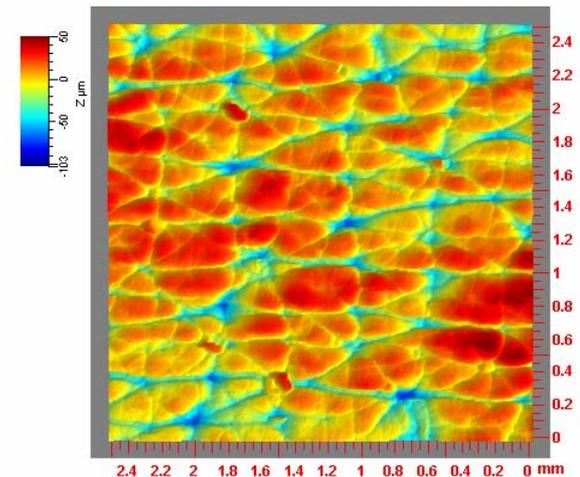
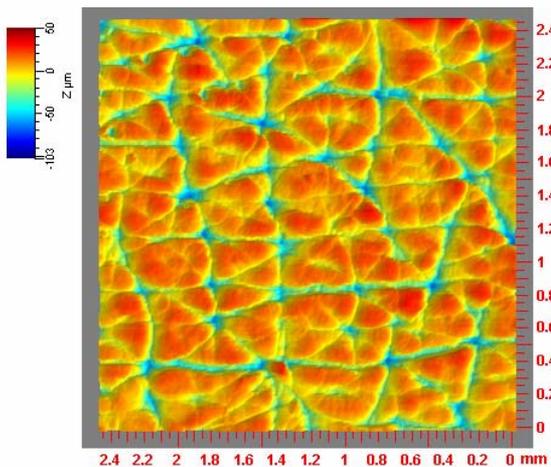
Après 12 mois de cure



PEAU  
«BRULÉE»

Restructuration  
du micro-relief

PEAU  
SAINE





# Mes cheveux colorés, lissés ...



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# Le cheveu



- Le cheveu est constitué de 95 % de kératine
- Il peut absorber 30% de sa masse en eau
- Mouillé son volume augmente de 20 à 30 %, il s'allonge de 10%.
- C'est la mélanine qui est responsable de la couleur des cheveux.
- Ce pigment brun naturel est produit dans l'épiderme.

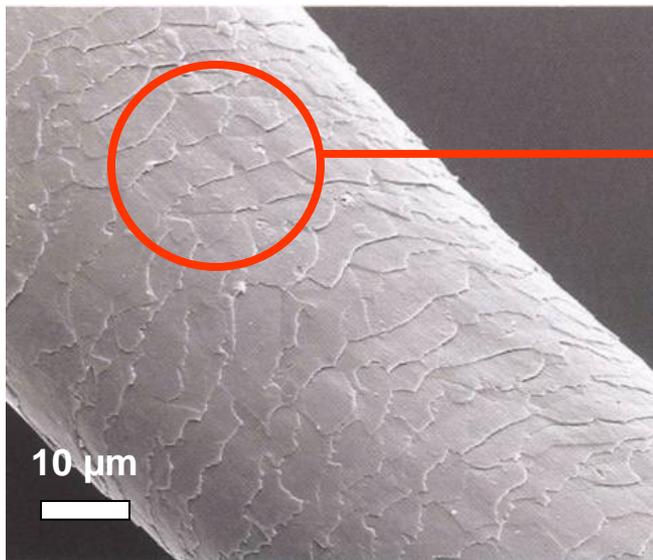
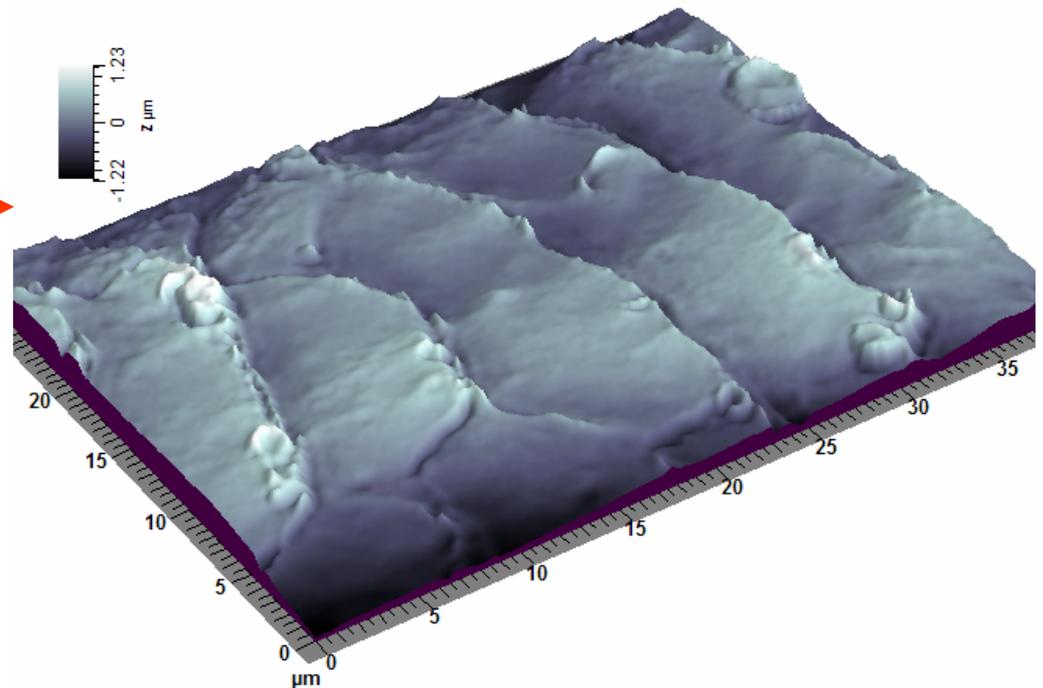


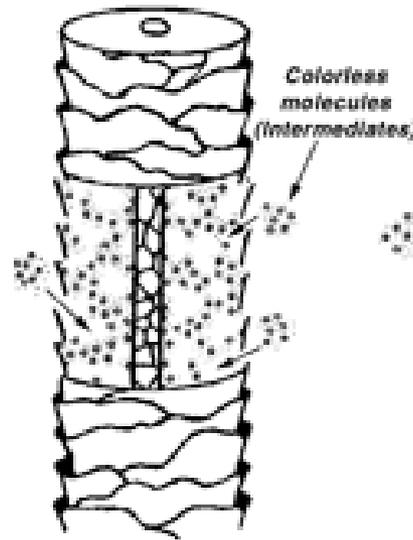
Photo au microscope électronique



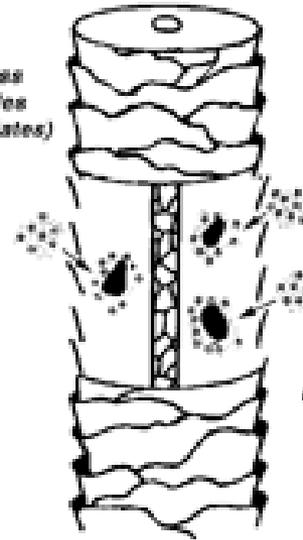
# Coloration des cheveux



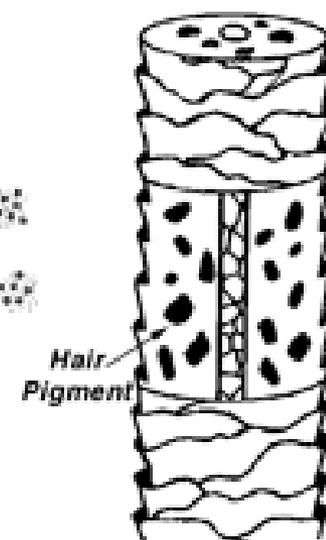
1) Ouverture des écailles



2) Oxydation du colorant



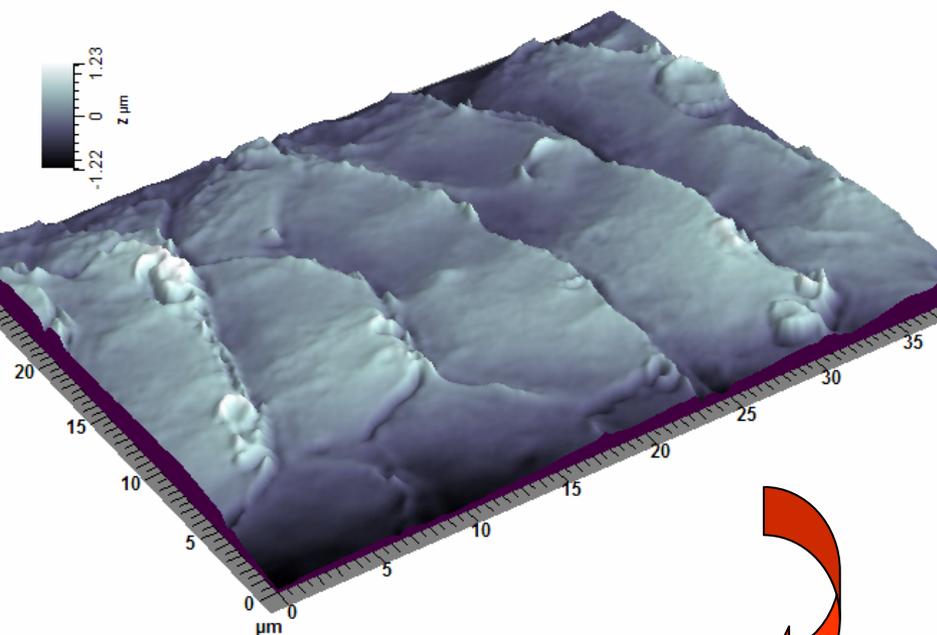
3) Fixation du colorant



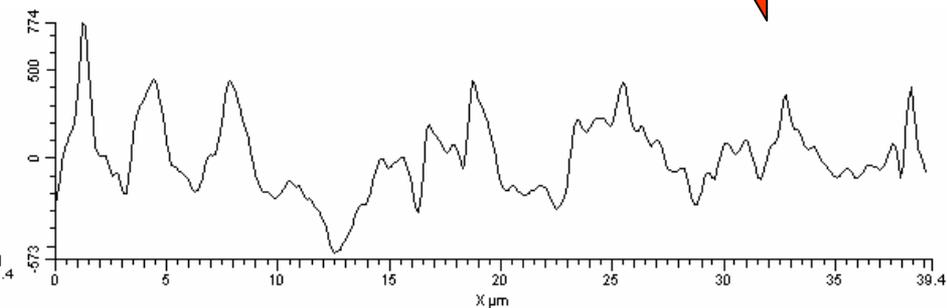
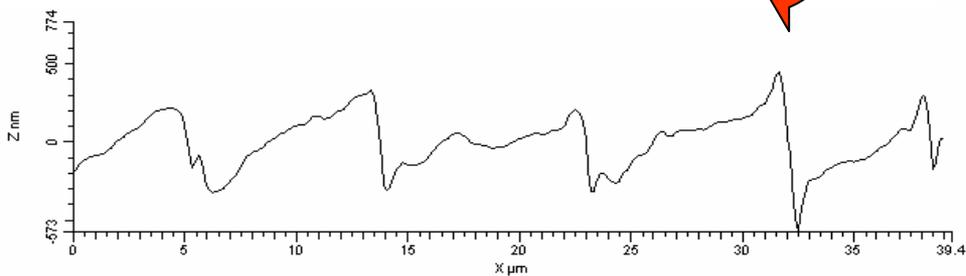
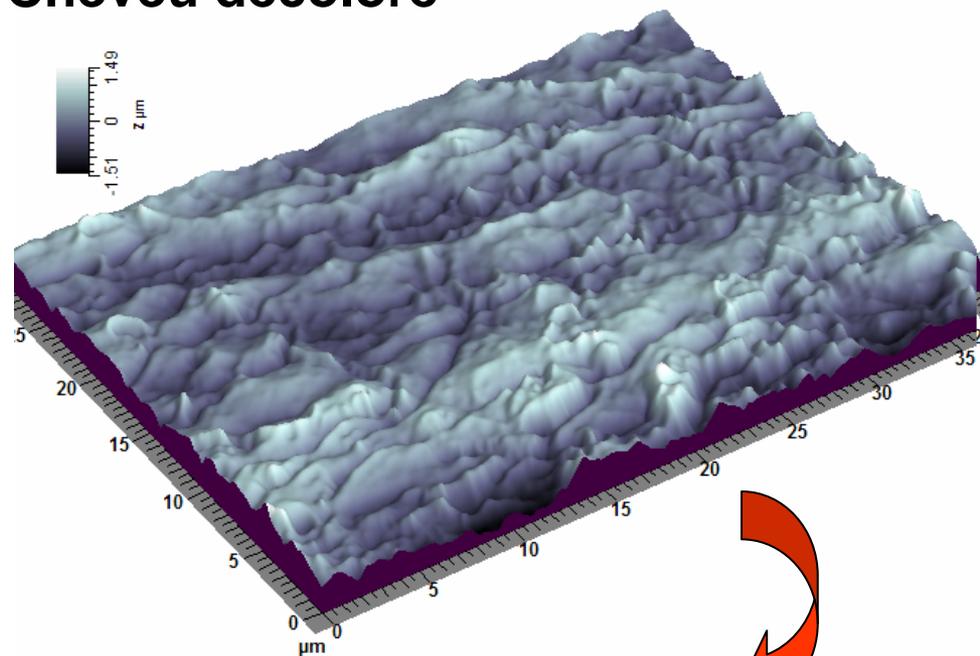
# Coloration des cheveux



## Cheveu naturel



## Cheveu décoloré



## Profils des écailles

# Lissage des cheveux



**Action  
thermo-mécanique  
 $T^{\circ} = 200^{\circ}\text{C}$**

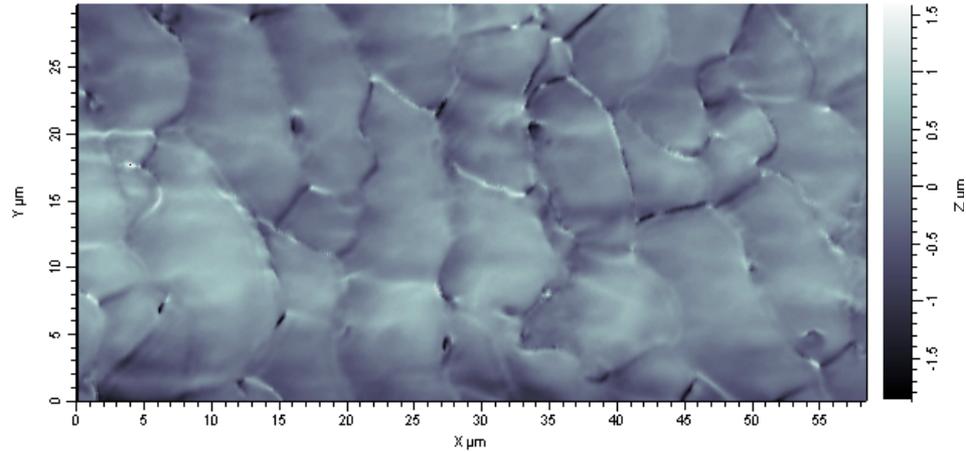


**Rendre le cheveu  
Plus lisse  
Plus brillant**

# Lissage des cheveux

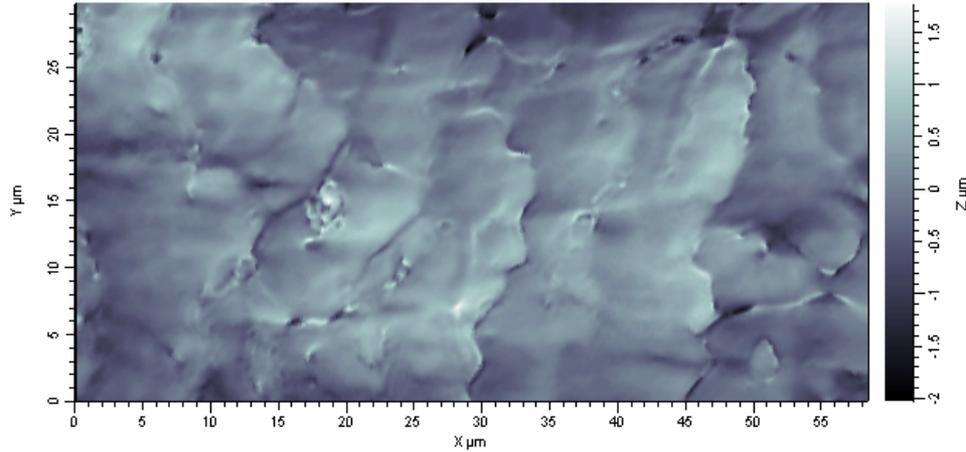


**MAUVAIS**

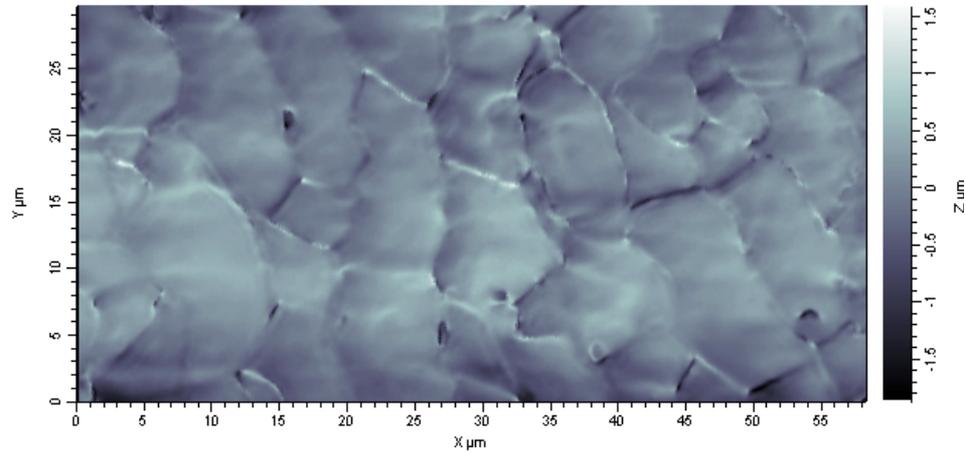


**Avant**

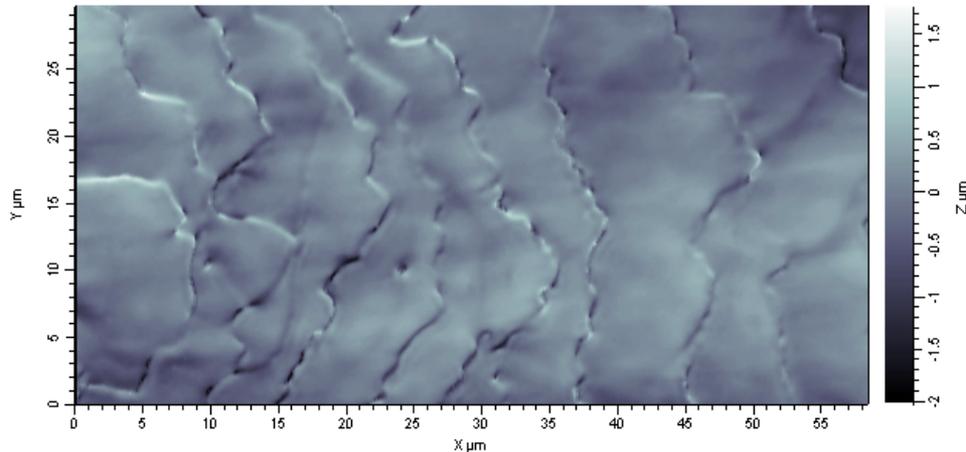
**BON**



**Avant**



**Après**



**Après**

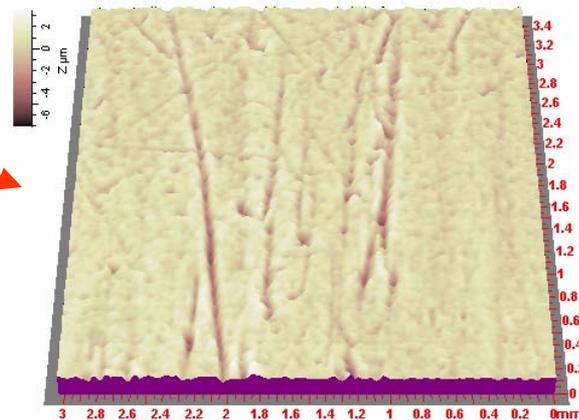
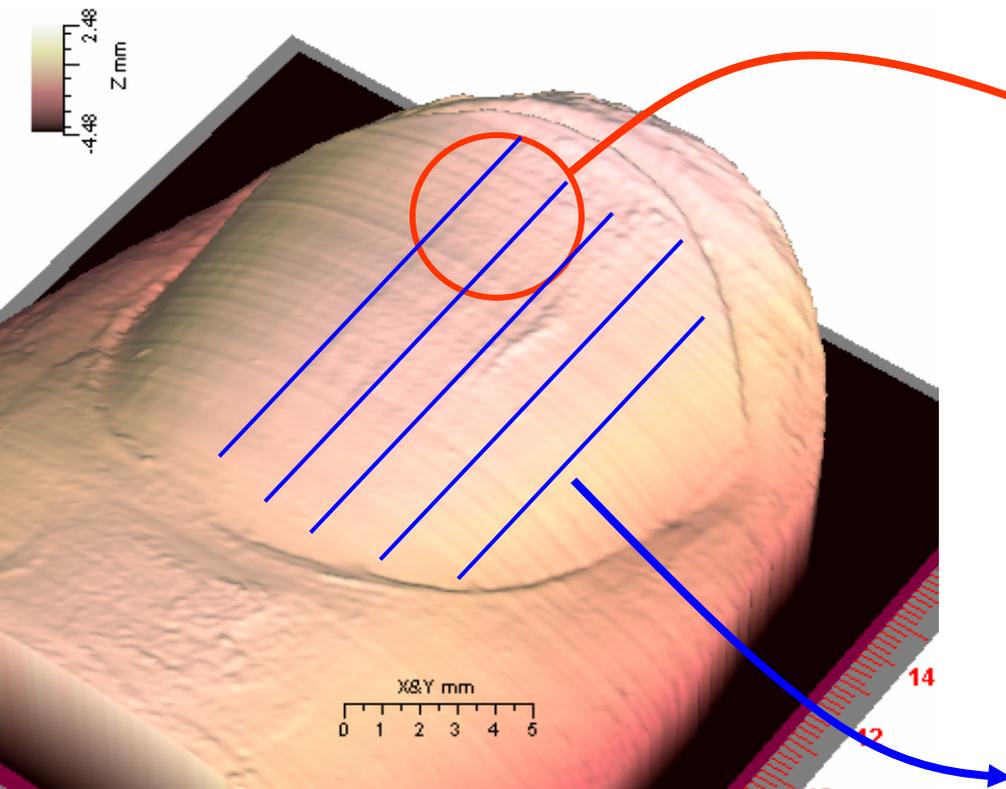


# Mes vernis à ongles



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# La surface de mes ongles



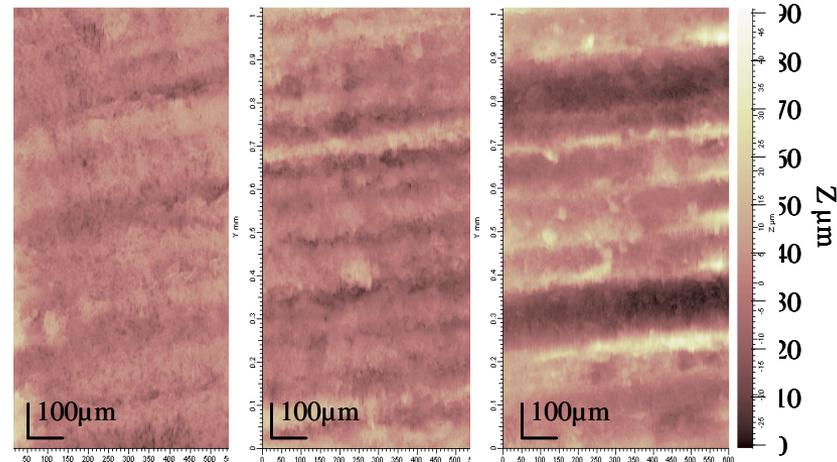
Agression de la surface de l'ongle

Comme le cheveu l'ongle est composé de kératine

20 mois

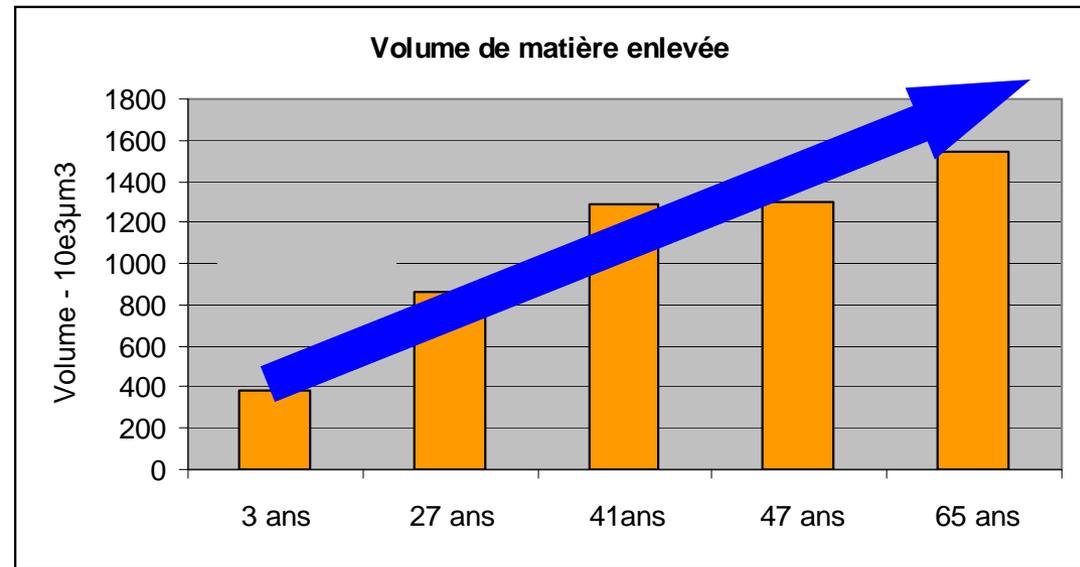
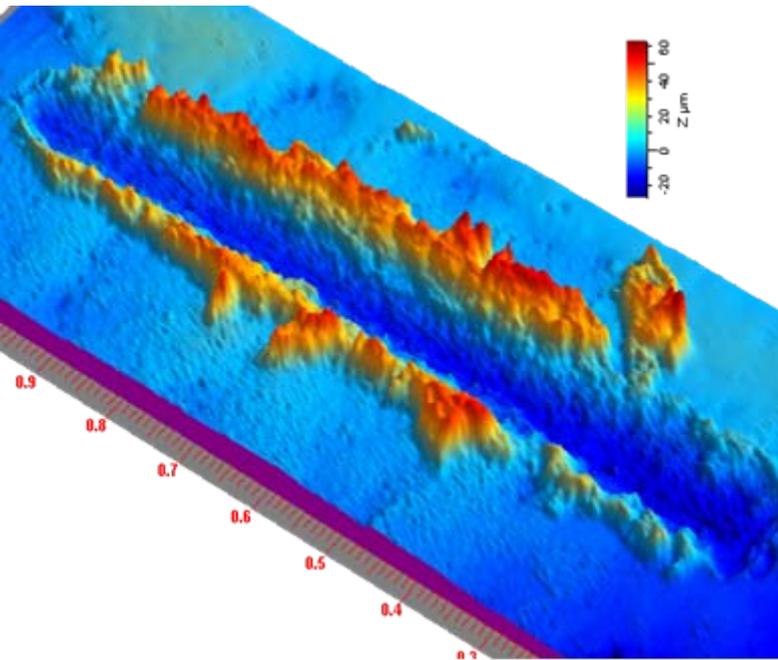
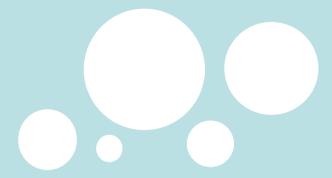
27 ans

65 ans



Vieillessement de la surface de l'ongle

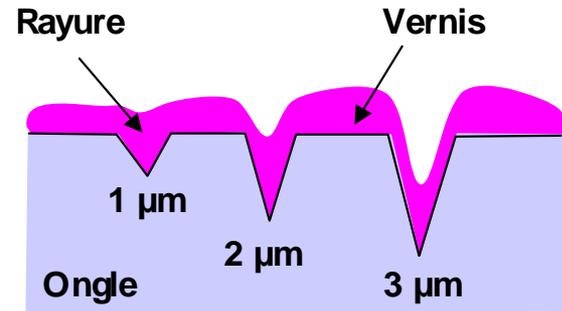
# Le vieillissement mécanique de mes ongles



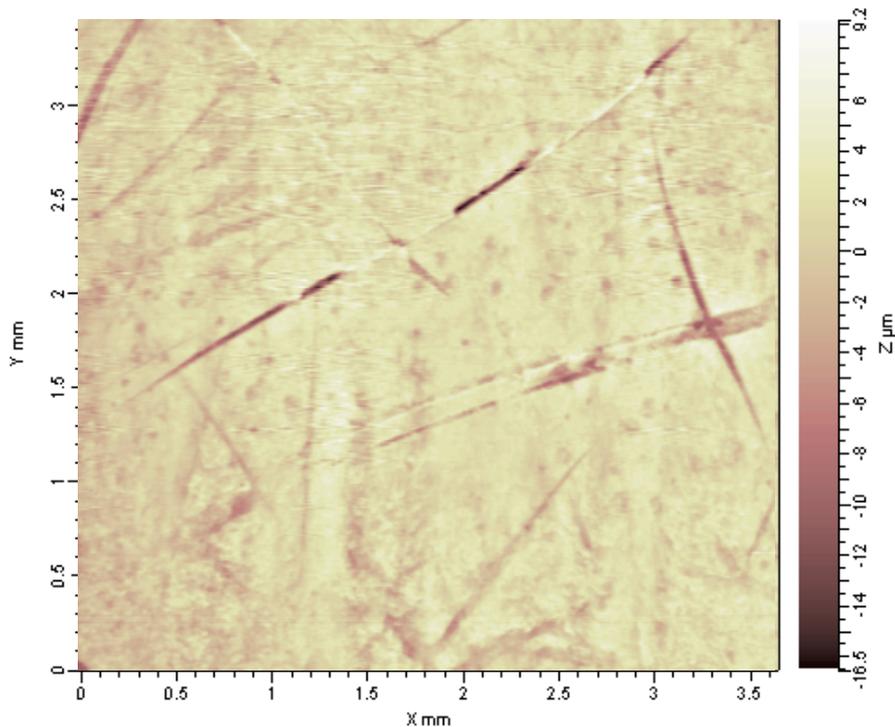
**Avec le temps la surface de l'ongle est plus sensible à l'abrasion**

# Evaluation des vernis qui cachent les défauts

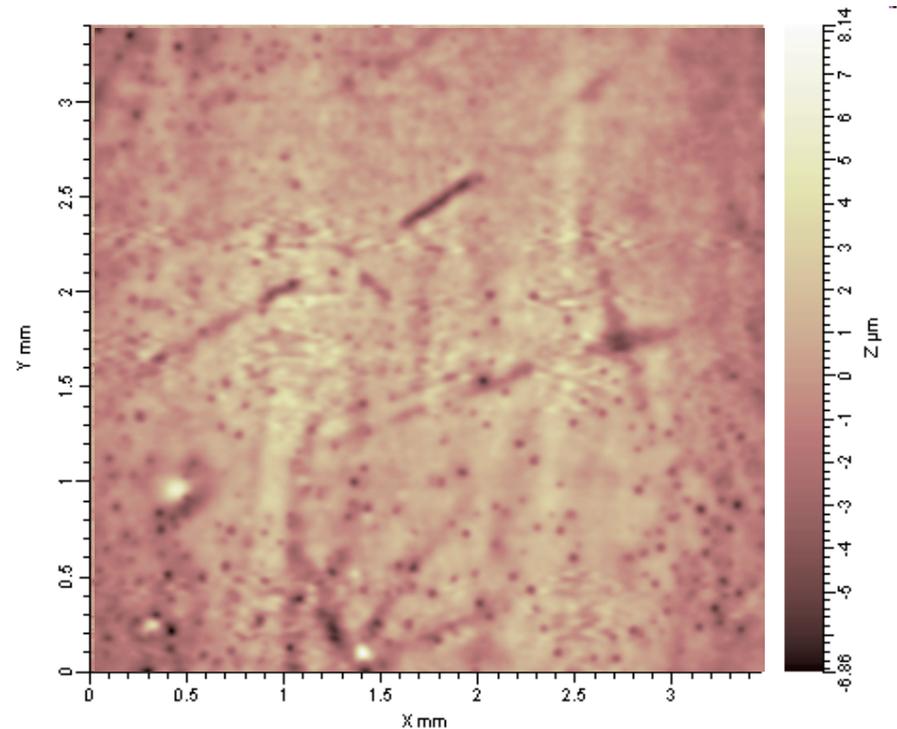
- Avec le temps, la surface de l'ongle laisse apparaître des imperfections telles que des lignes et des stries d'abrasion.
- Ces phénomènes s'intensifient avec l'âge du fait des modifications morphologiques et mécaniques de l'ongle.



**Avant**



**Après**



# Evaluation des vernis qui apportent de la couleur

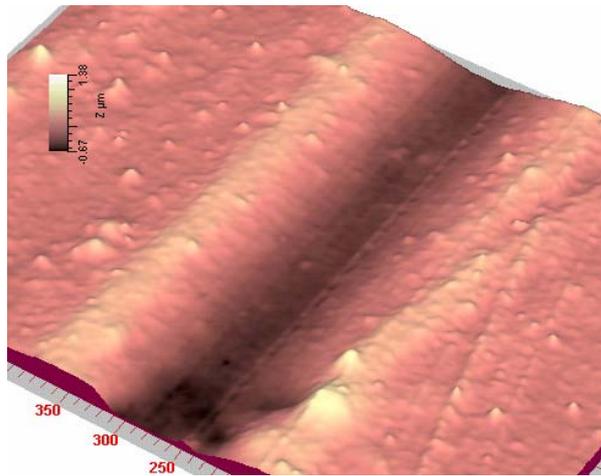


- Tests de résistance à l'abrasion
- Tests d'usure

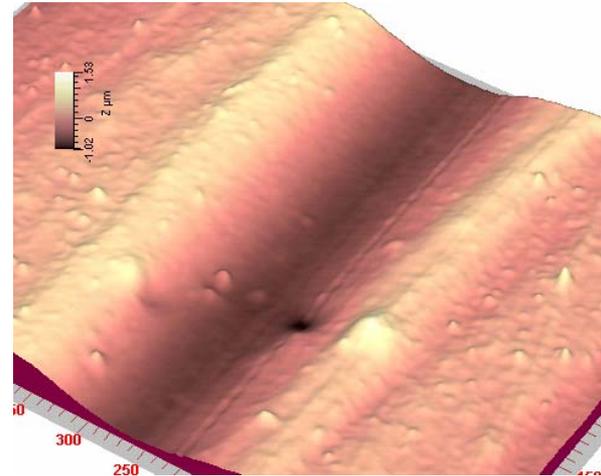
# Comparaison de deux vernis: test d'usure



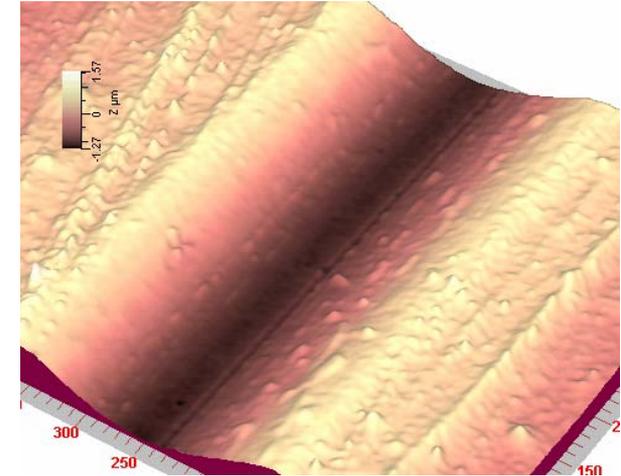
Vernis 1 - 100 cycles



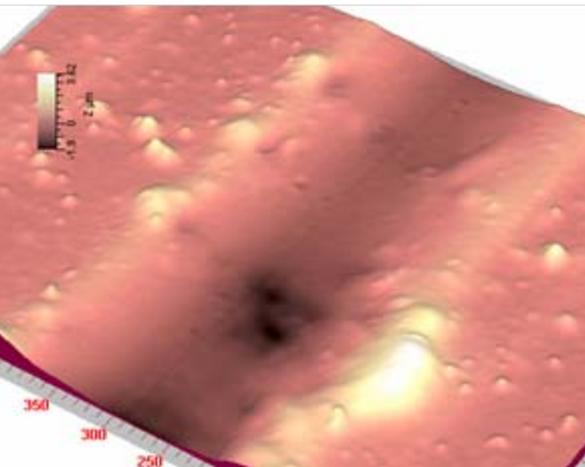
Vernis 1 - 500 cycles



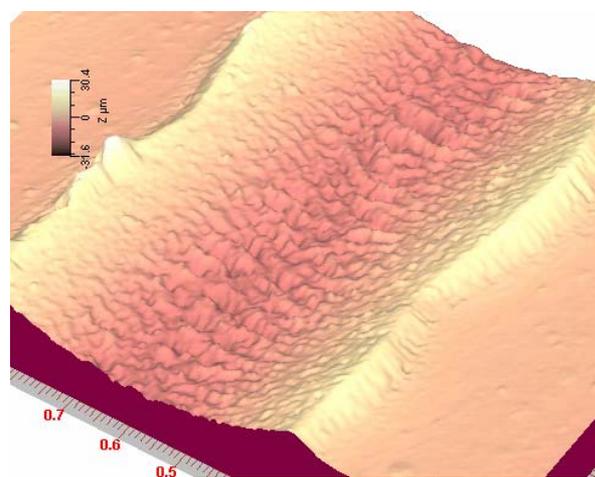
Vernis 1 - 1000 cycles



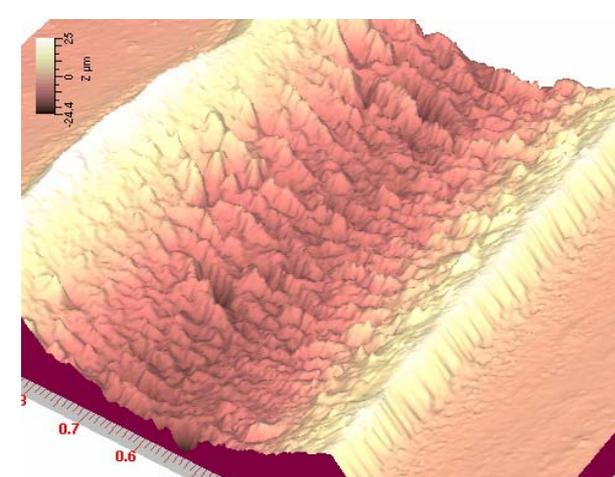
Vernis 2 - 100 cycles



Vernis 2 - 500 cycles



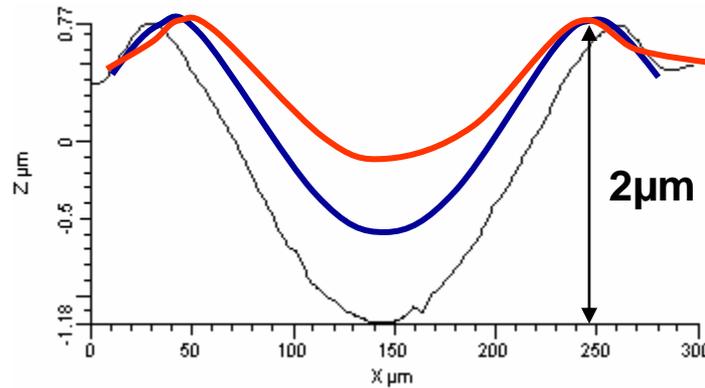
Vernis 2 - 1000 cycles



# Comparaison de deux vernis: test d'usure

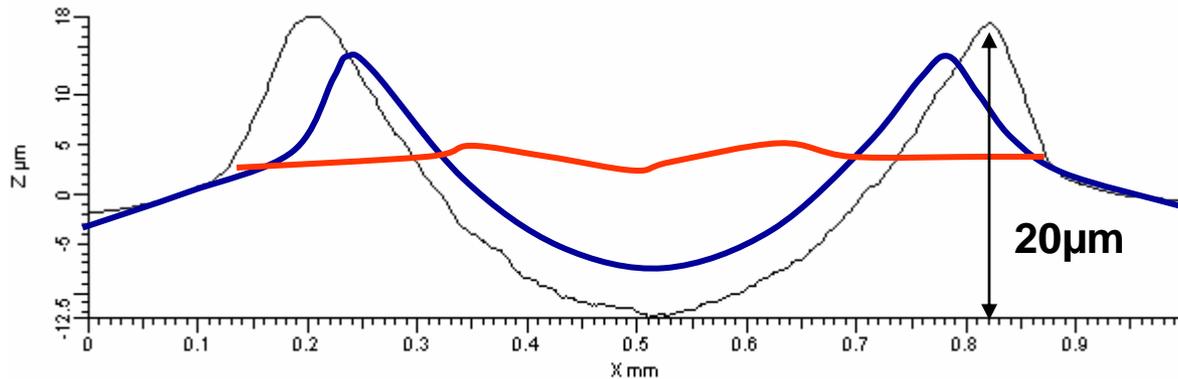


Vernis 1

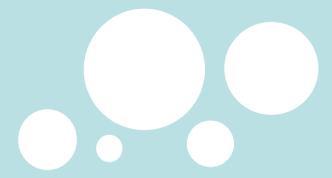


100 cycles  
500 cycles  
1000 cycles

Vernis 2



100 cycles  
500 cycles  
1000 cycles



# Peut-on mesurer la douceur ? de la peau, des cheveux, des tissus...

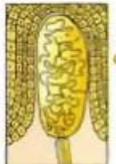
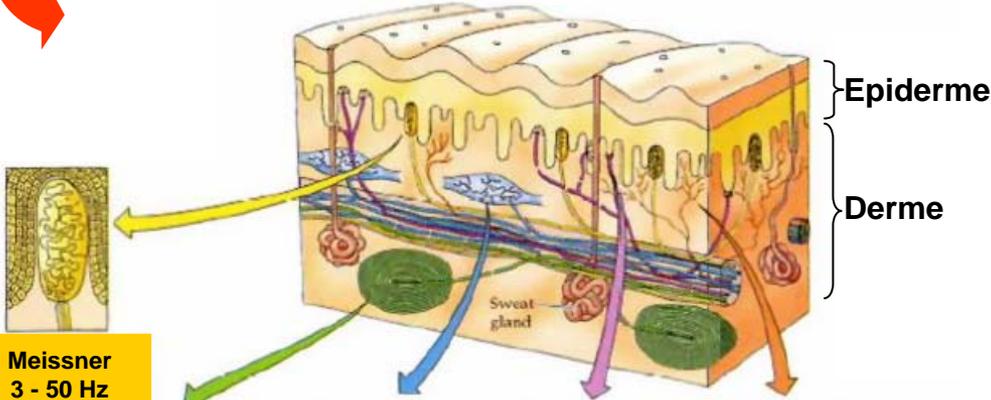
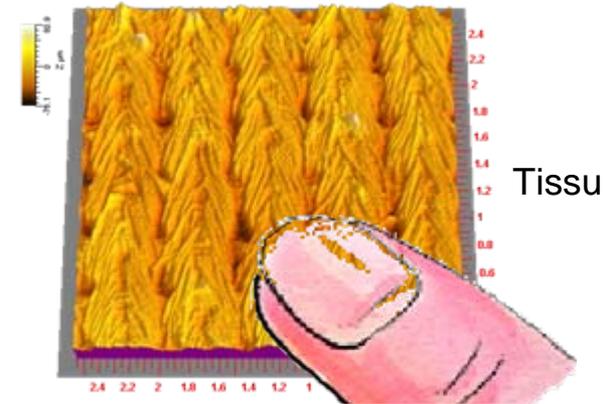


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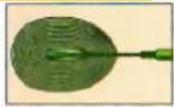
# Métriologie sensorielle: *les mécanorécepteurs du doigt*



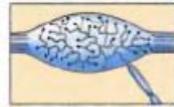
Relief des empreintes digitales  
+ 2000 mécanorécepteurs /cm<sup>2</sup>



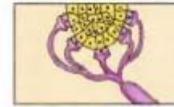
**Meissner**  
3 - 50 Hz



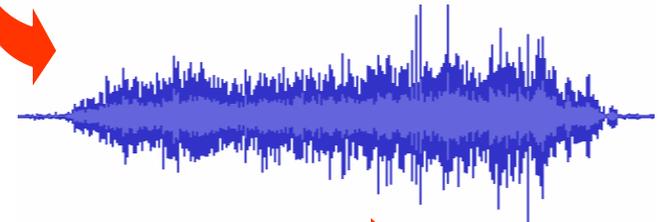
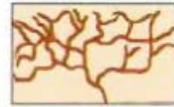
**Pacini**  
10 - 1200HZ



**Ruffini**  
15 - 400 Hz

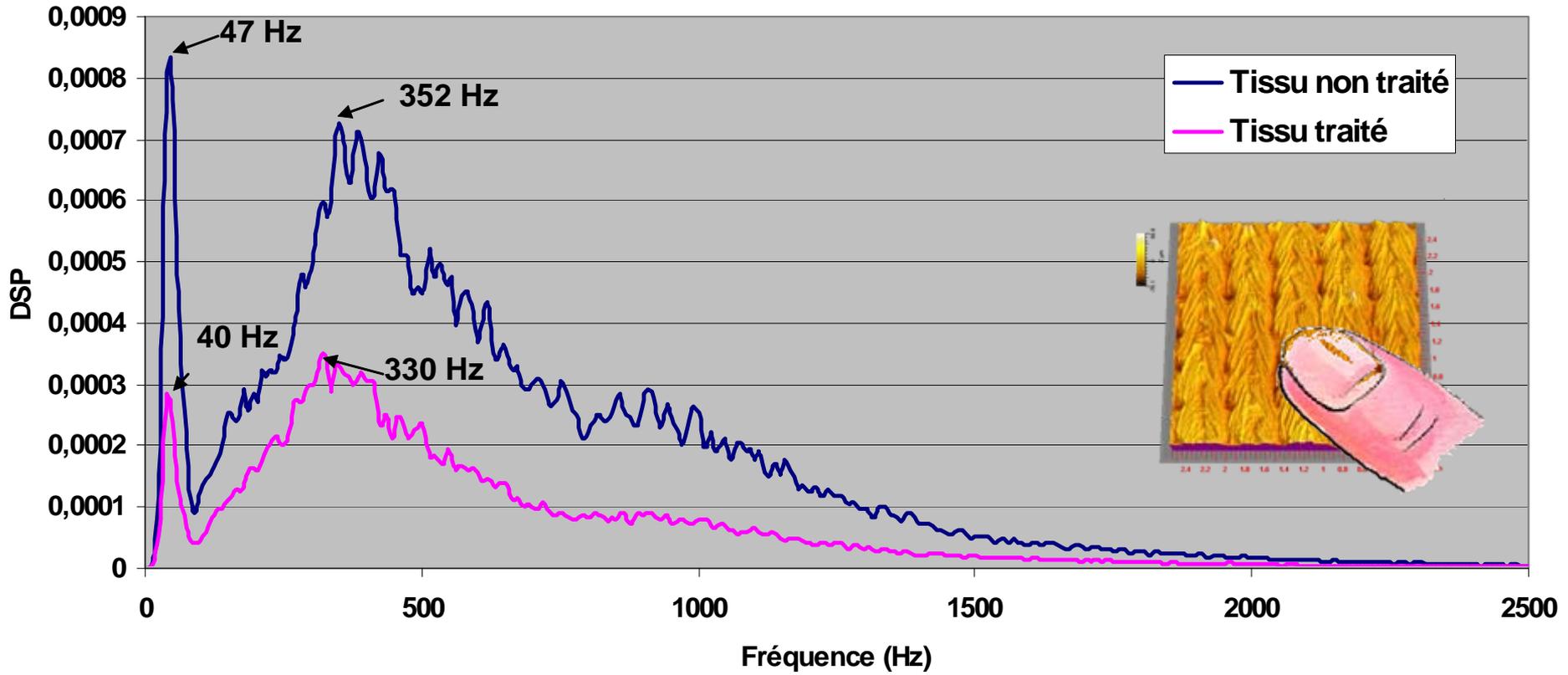
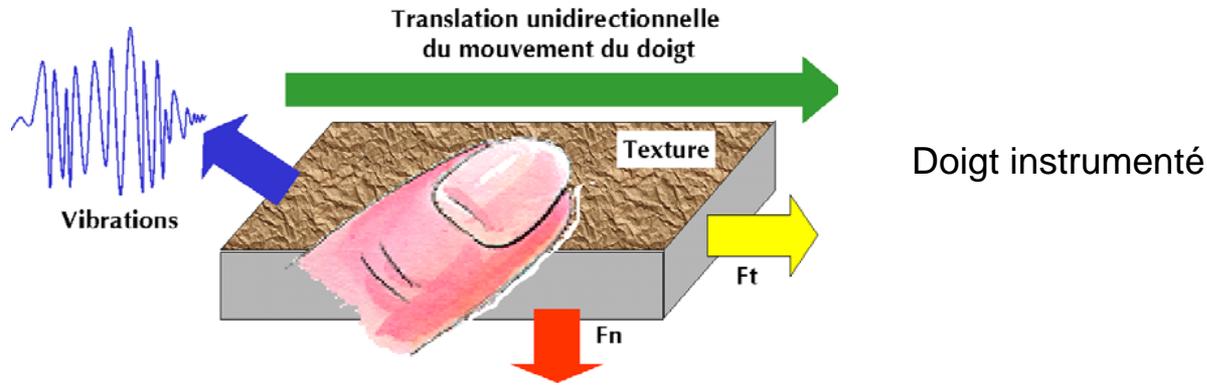


**Merkel**  
0,3 - 3 Hz



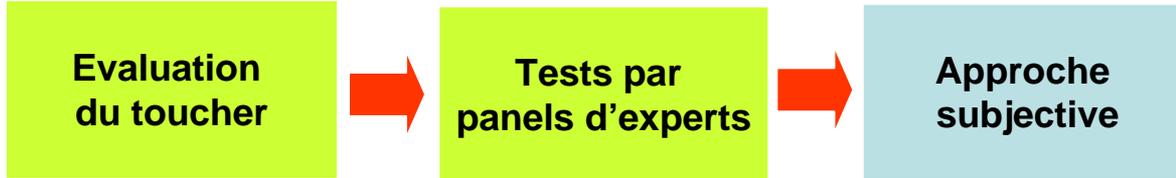
Vibrations → Cerveau

# Vibrations transmises au doigt par un tissu



# Comment évaluer le toucher ?

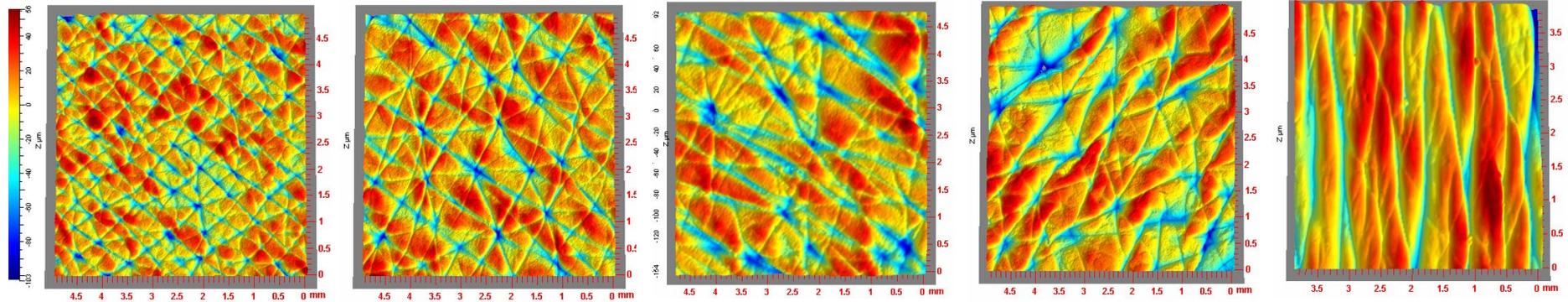
## • Approche subjective : le panel



## • Approche objective : la sonde tribo-acoustique



# Sonde tribo-acoustique: *application à la peau*



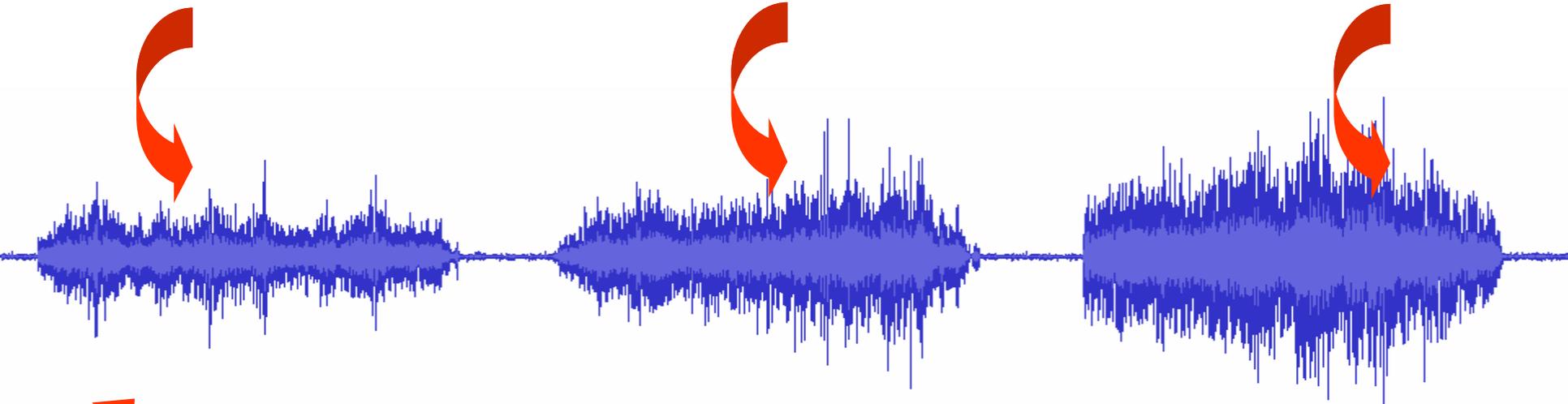
30-40 ans

40-50 ans

50-60 ans

60-70 ans

70-80 ans



**Augmentation du niveau vibratoire  
en fonction des classes d'âge**

**Douceur  
de la peau**

# Sonde tribo-acoustique: *application aux cheveux*

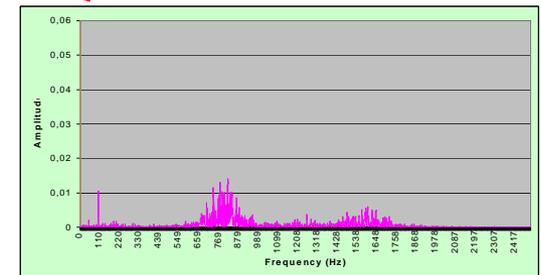
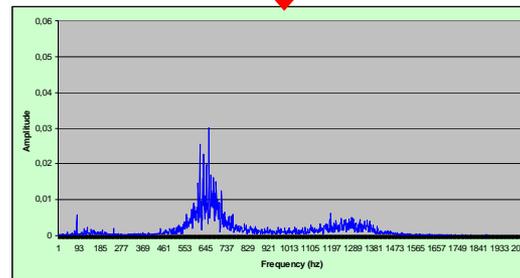
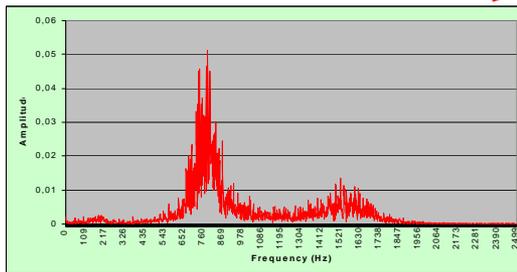
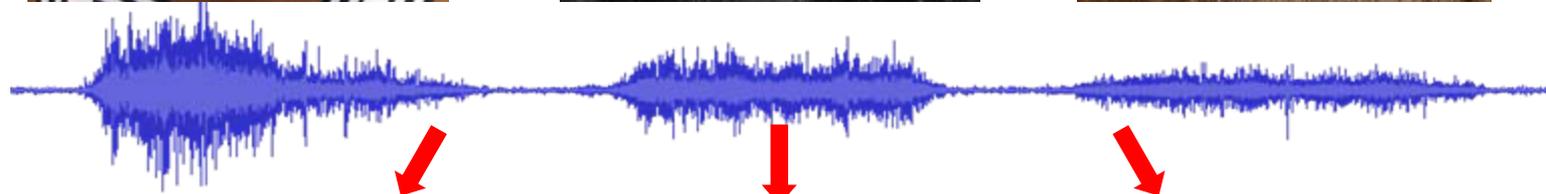
Africain



Japonais



Caucasien



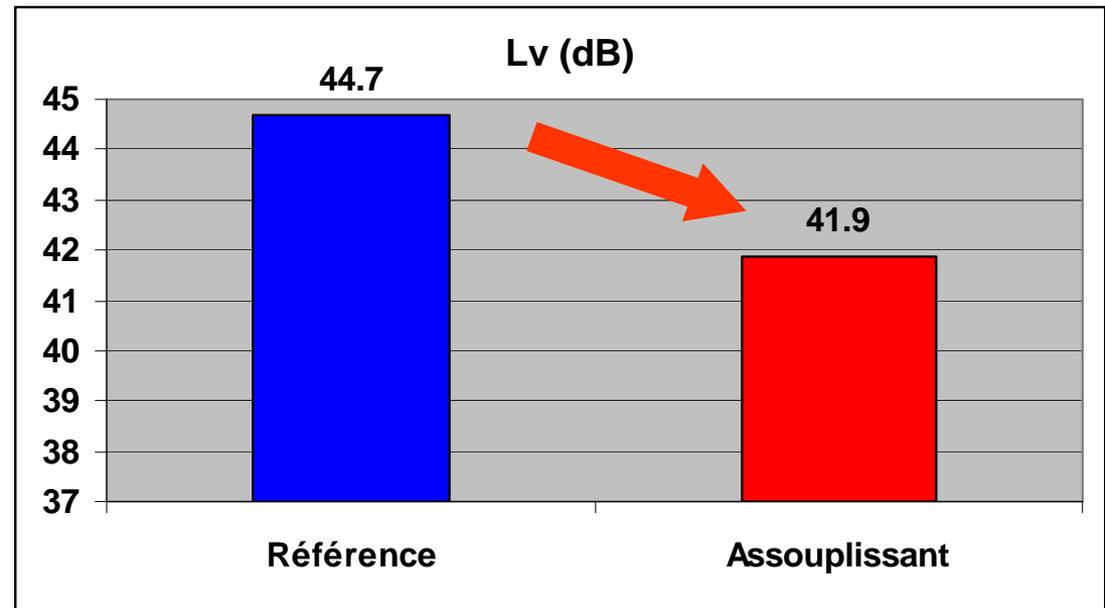
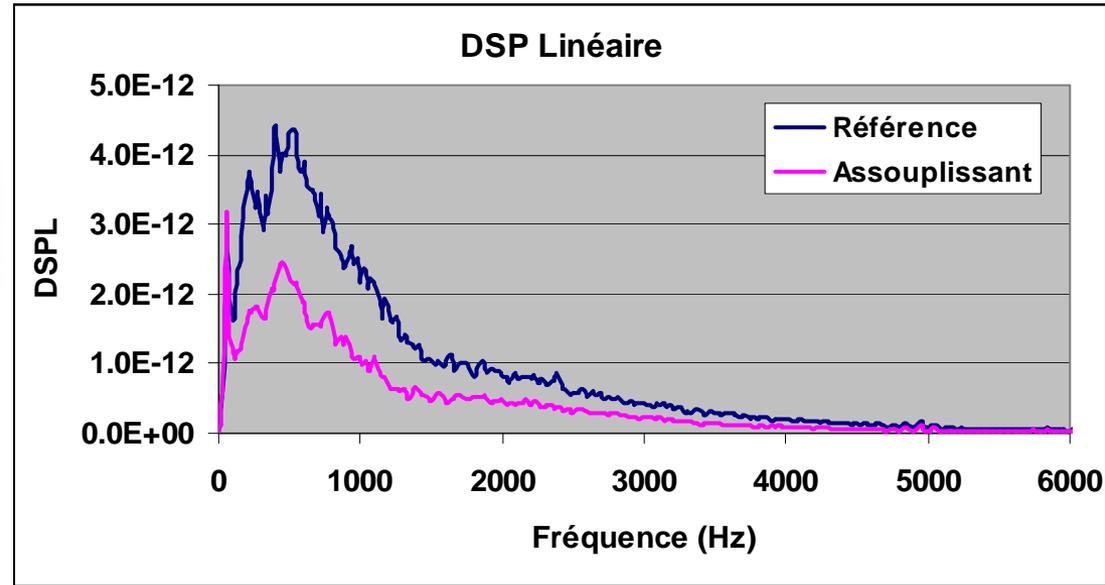
Applications



Champoing  
Coloration  
Lissage

# Sonde tribo-acoustique: application aux tissus

## Evaluation de la douceur d'un assouplissant



Soin du linge  
Luxe  
Sport

## Tribologie : science du frottement et de l'usure

### Ingénierie du vivant:

Vieillesse cutané

Cheveux

Ongles

Santé

Cosmétique



**COULEURS  
SUR  
CORPS**



### Métrologie sensorielle:

Peau/cheveux/pelage

Habillement

Luxe



Biennale de la Danse – Lyon 2008