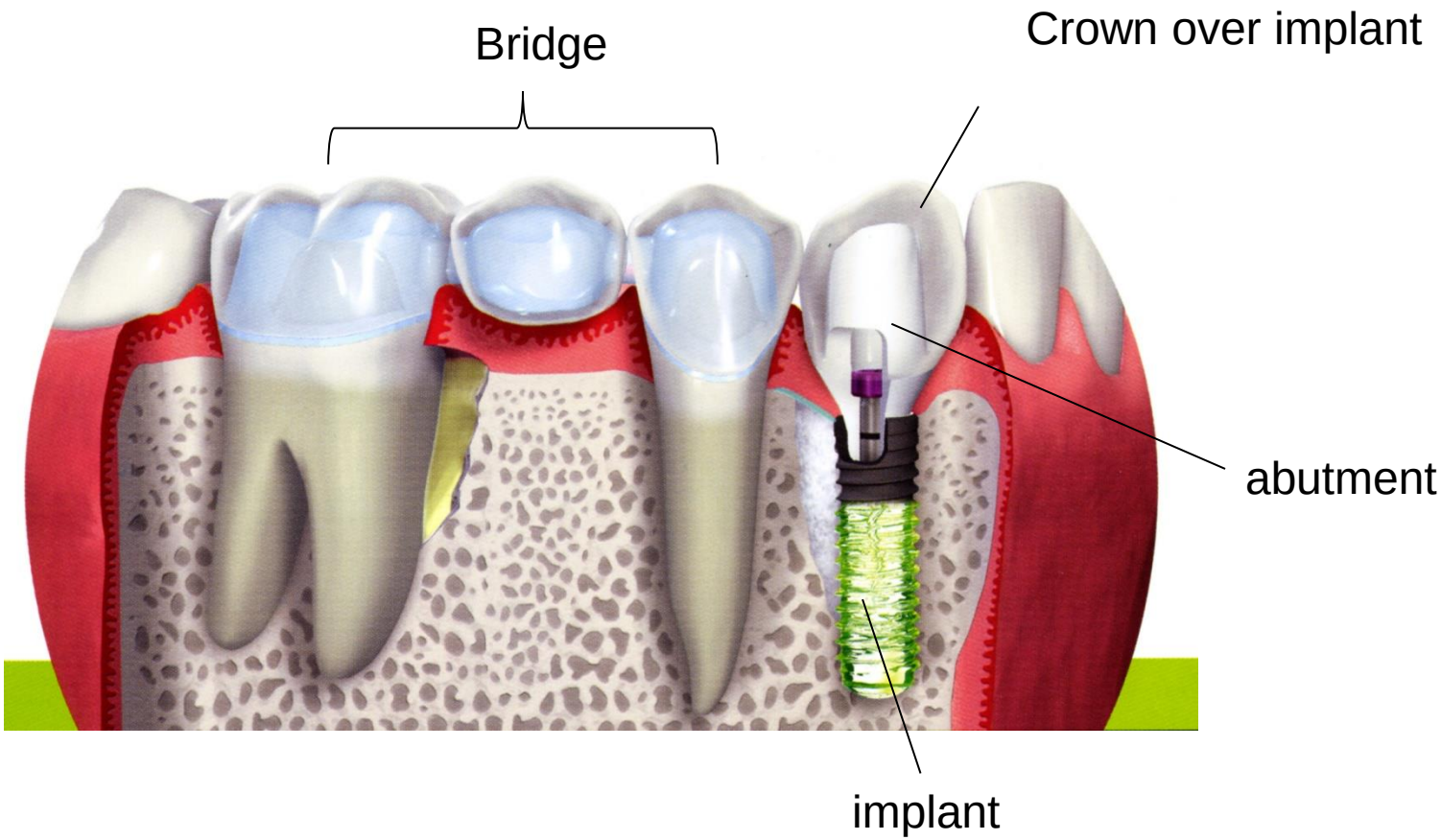
Dental ceramics and their clinical drawback



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susanne.scherrer@unige.ch

Dental ceramics and their clinical drawback

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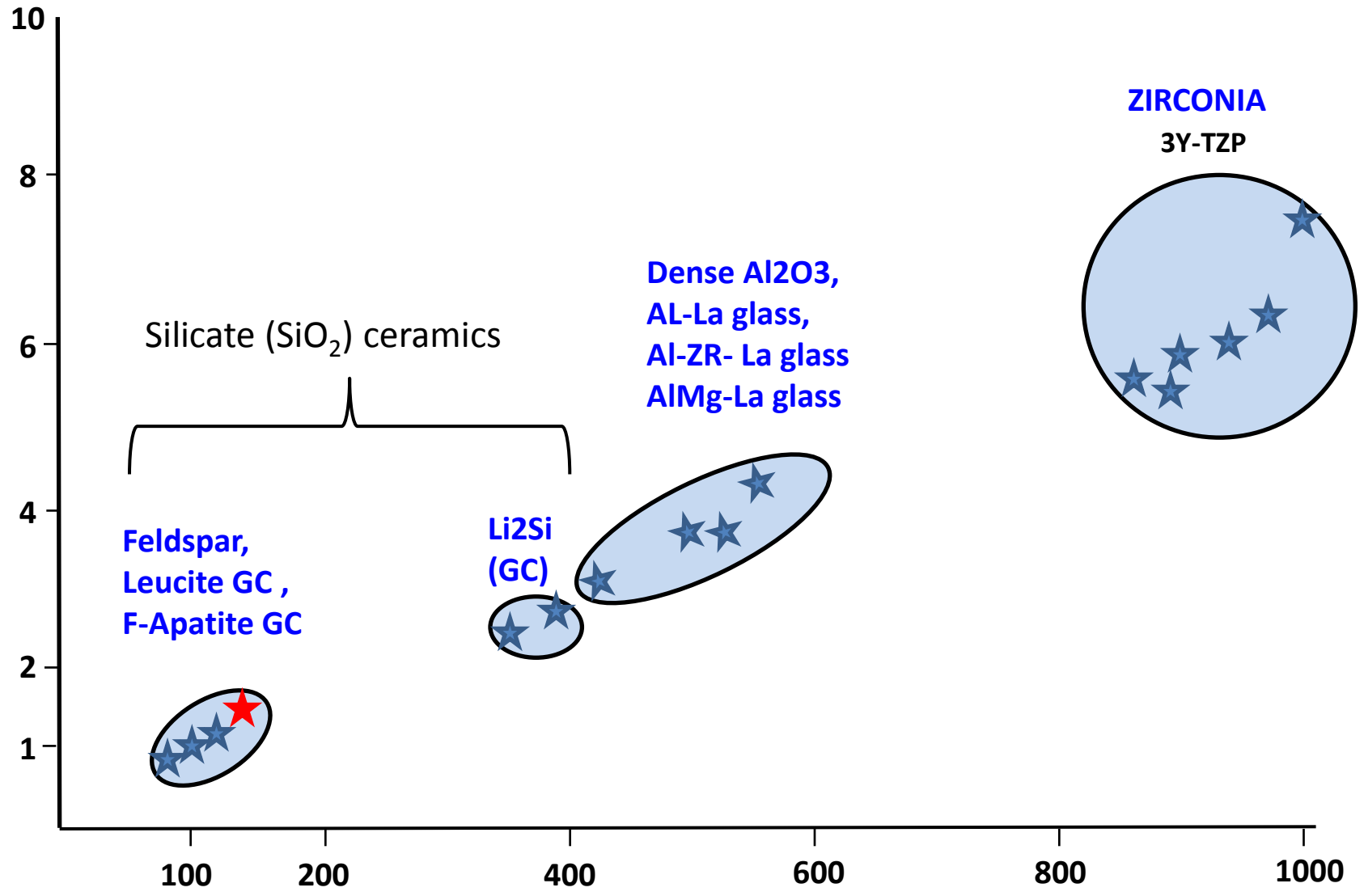
Ceramic materials overview

(Resistance to crack propagation)

Toughness (MPa√m)



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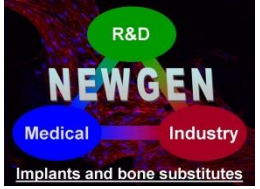
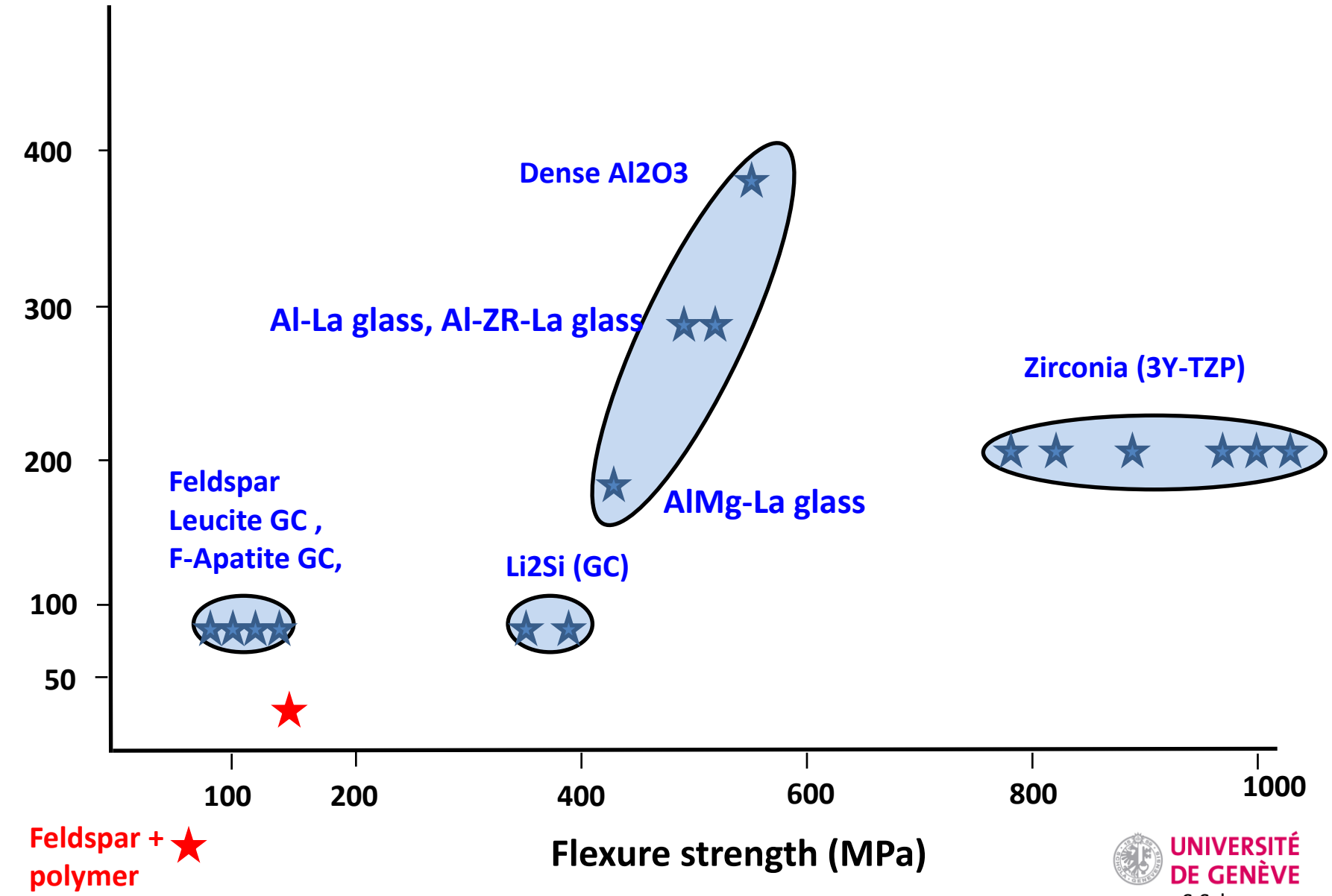
Ceramic materials overview





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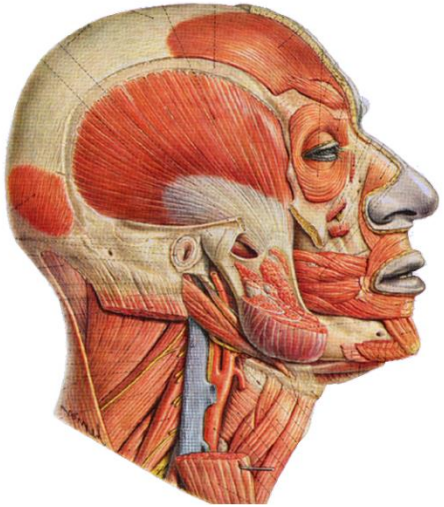
Clinical problems

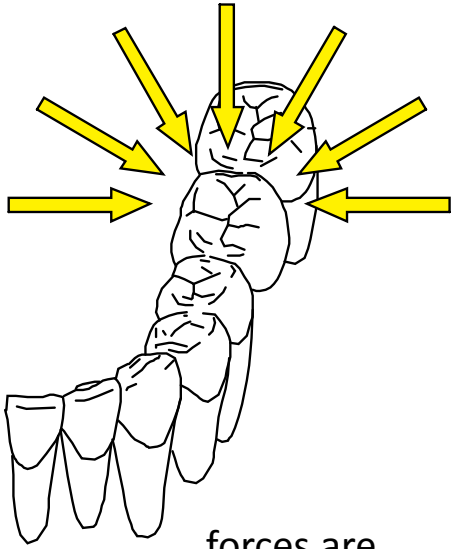
Mastication forces: high peak loads, cyclic loading (fatigue)



Powerfull jaw closer muscles (masseter, temporalis, pterigoid) can crack teeth, fracture ceramic and noble metal alloys (Au-Pd)

Guinness world record = 4000 N on molars

Mastication forces between 200 N - 800 N



forces are multidirectional

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Clinical problems

Ceramic fractures (mechanics!!!!)

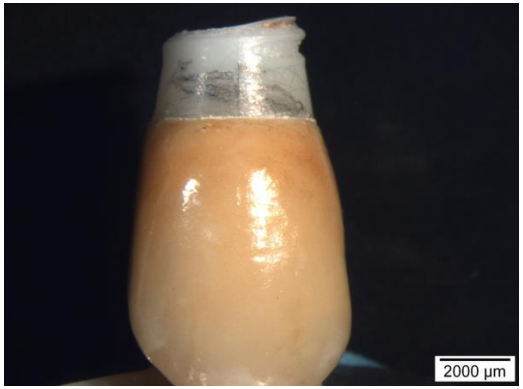
a) design issues

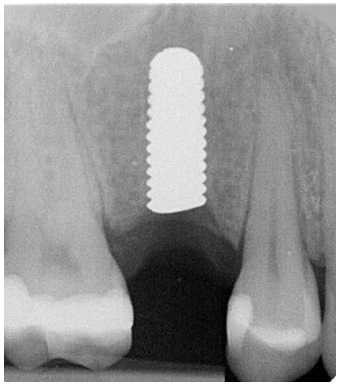
b) processing issues

c) mastication (force, multidirection)

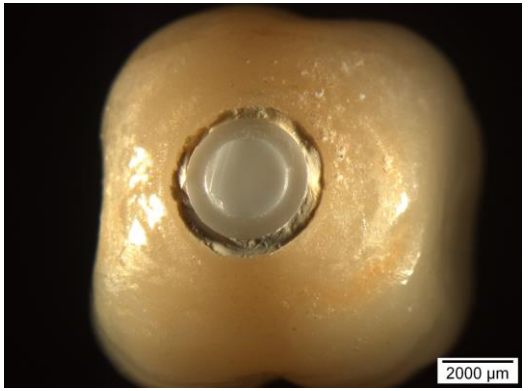
Crown fracture / chipping

Implant fracture





Abutment fracture



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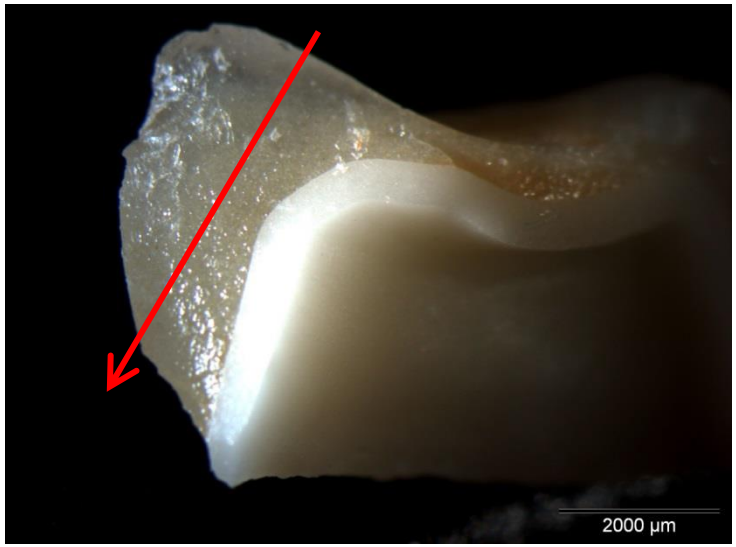
Clinical problems

Ceramic fractures (mechanics!!!!)

1. veneer fractures (chips)



Clinical problems

Ceramic fractures (mechanics!!!!)

2. Bulk fracture (monolithic glass-ceramic)

Clinical problems

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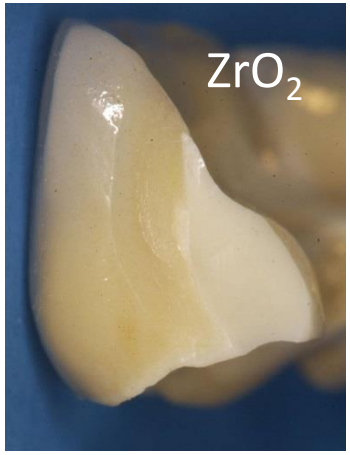
Ceramic fractures (mechanics!!!!)

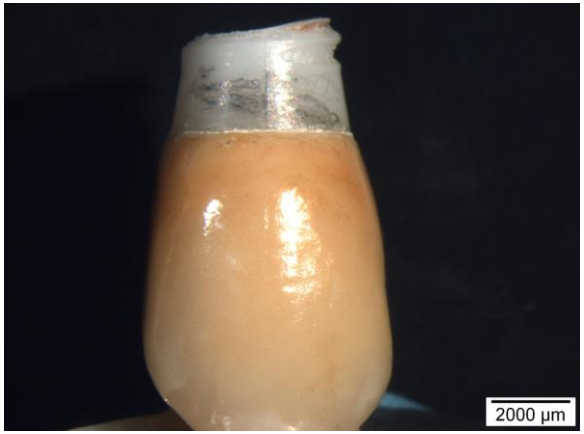
3. Bulk fracture (veneer + core)

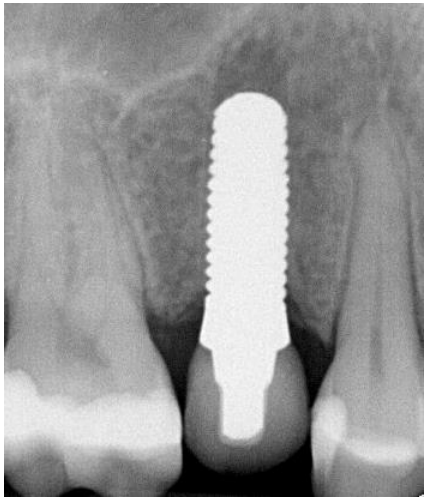


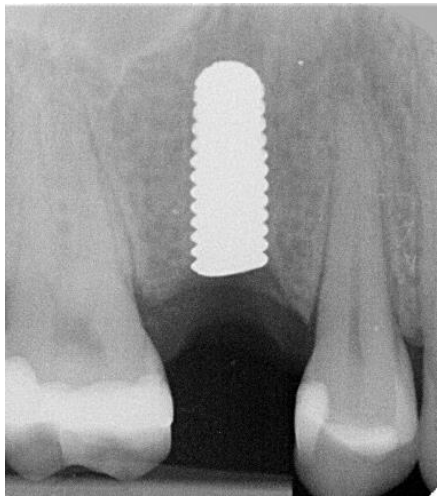
Clinical problems

Ceramic fractures (mechanics!!!!)

4. Bulk fracture (zirconia implant)



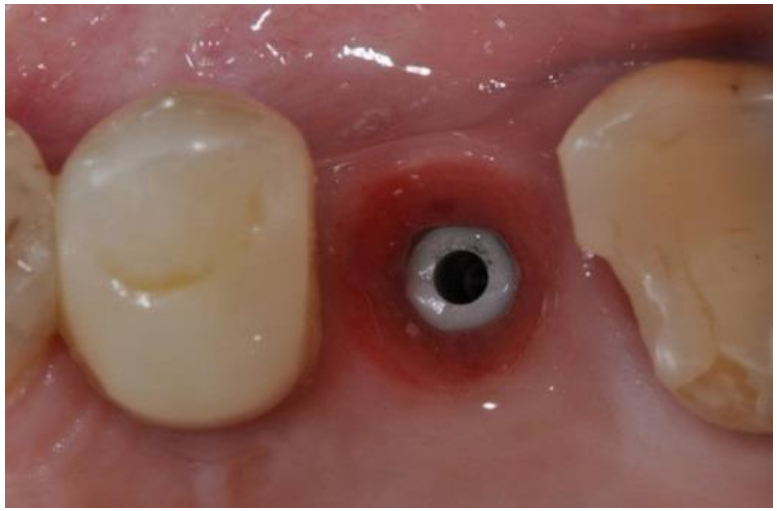


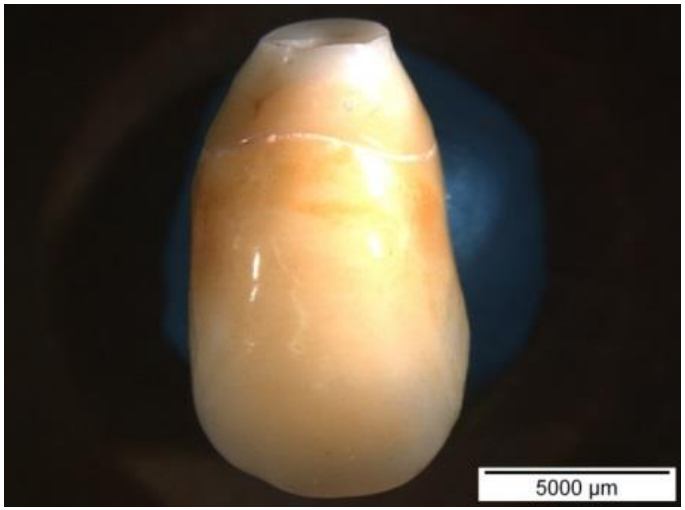


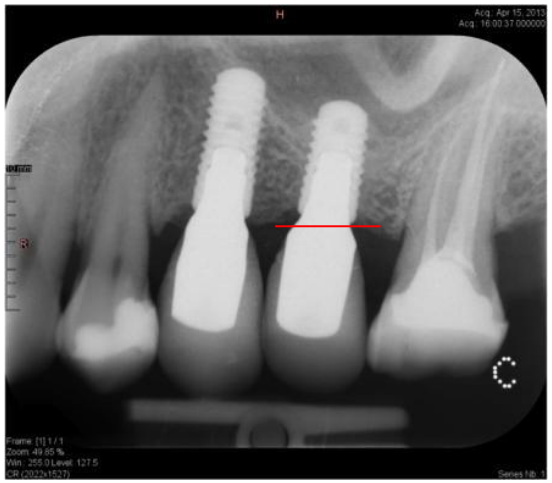
Clinical problems

Ceramic fractures (mechanics!!!!)

5. Bulk fracture (zirconia abutment)







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A material science approach for understanding clinical ceramic failures

Longitudinal clinical study all-ceramic restorations

↓

Clinical failures → Material sciences

- Microstructure & mechanical properties
- Fracture mechanics (K_{Ic})
- Fractographic failure analysis
- Fatigue behavior

→ Clinical & lab recommendations




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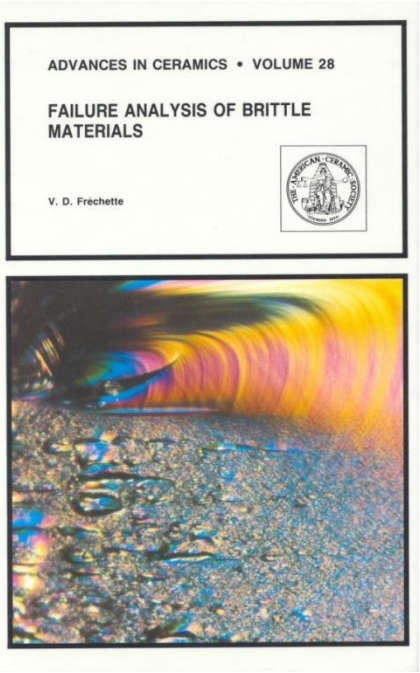
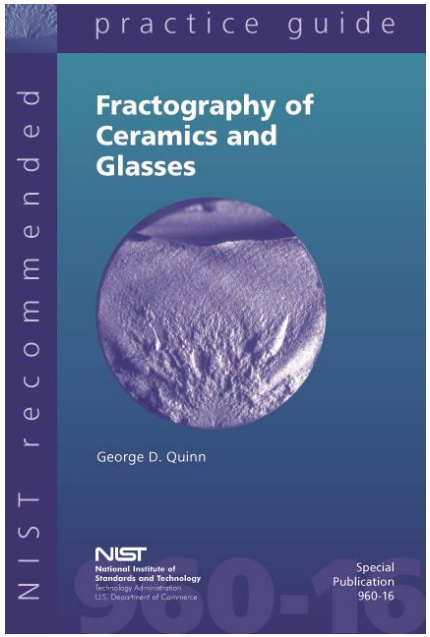


V.D. Fréchette
2006

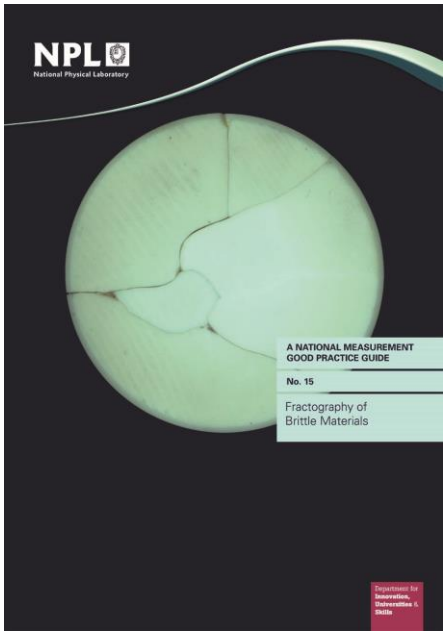
ASTM INTERNATIONAL

Designation: C 1322 – 05a

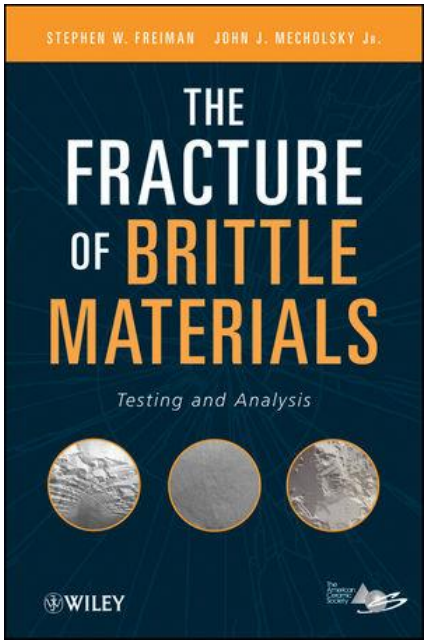
Standard Practice for Fractography and Characterization of Fracture Origins in Advanced Ceramics[1]



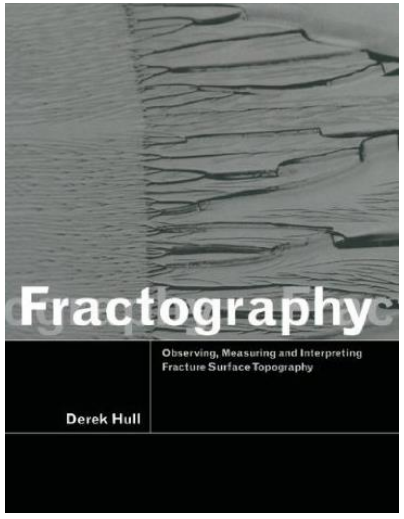
G.D. Quinn
2007



R. Morrell
2008



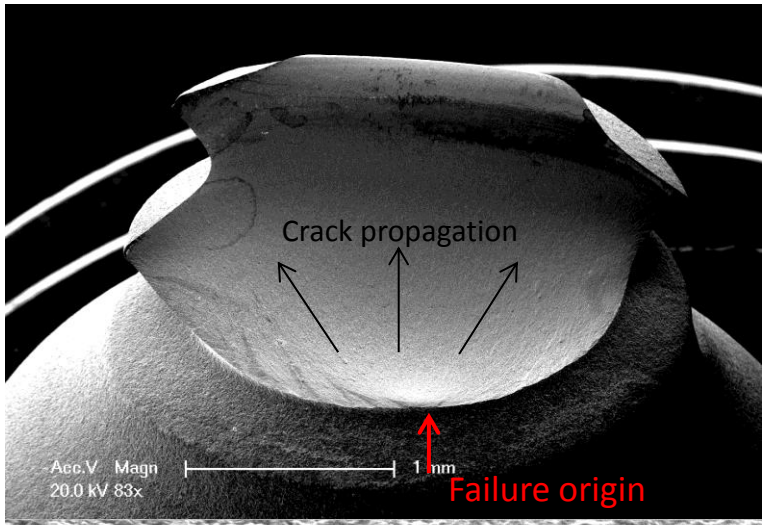
S.W. Freiman
J.J. Mecholsky Jr
2012

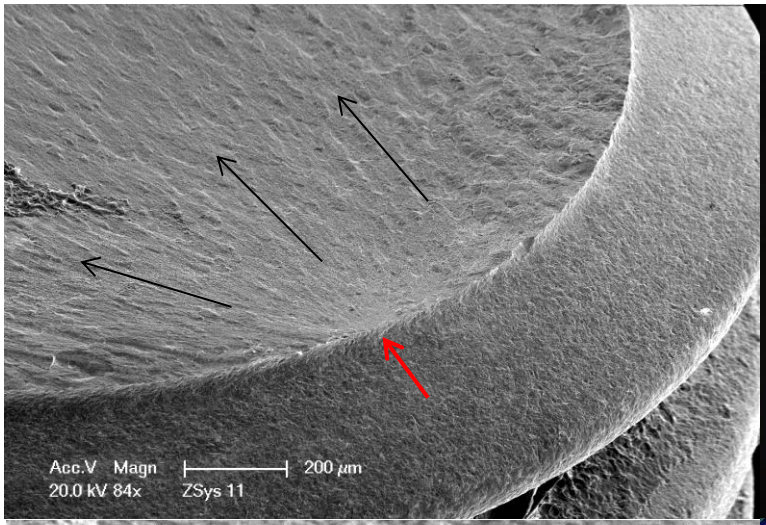


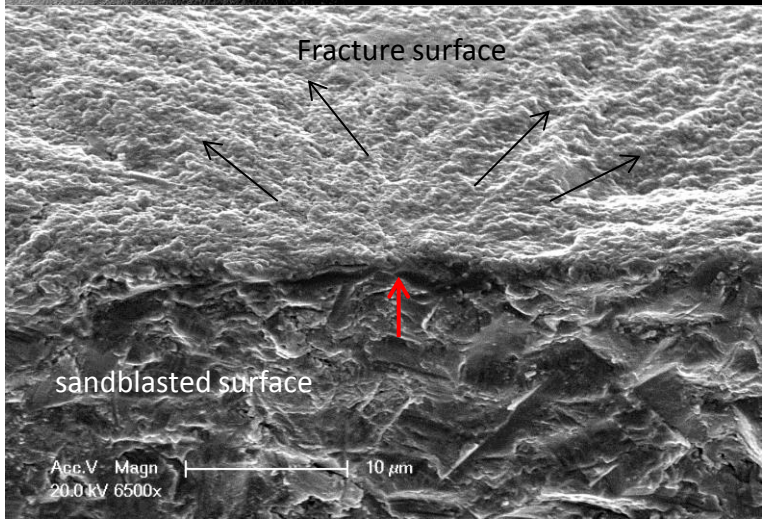
D. Hull (1999)

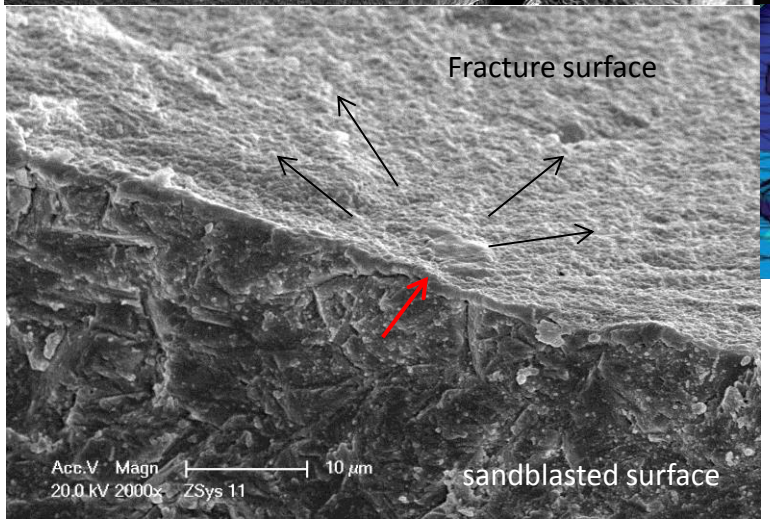
Fractography of clinically failed parts

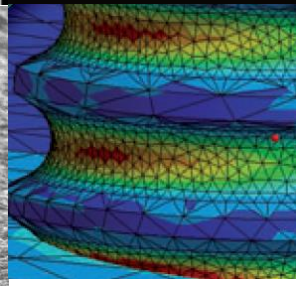
Implant processing issues (surface texture) & design issues











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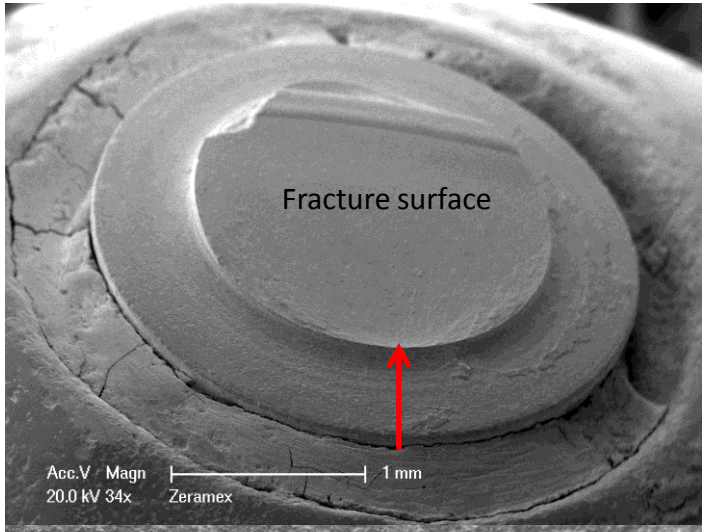
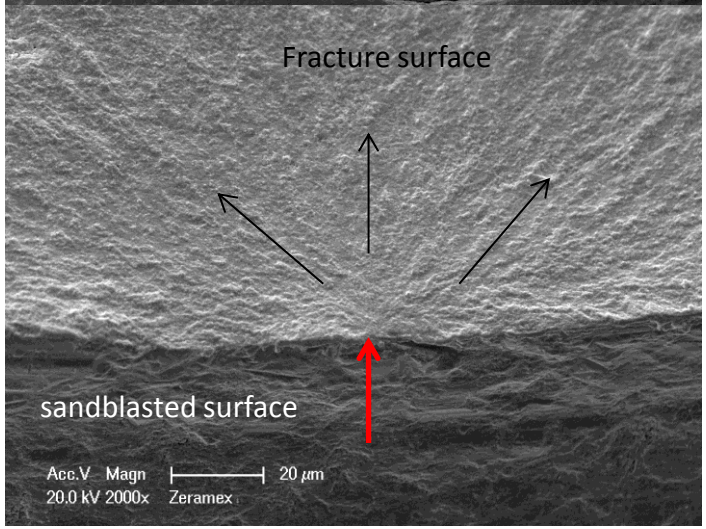
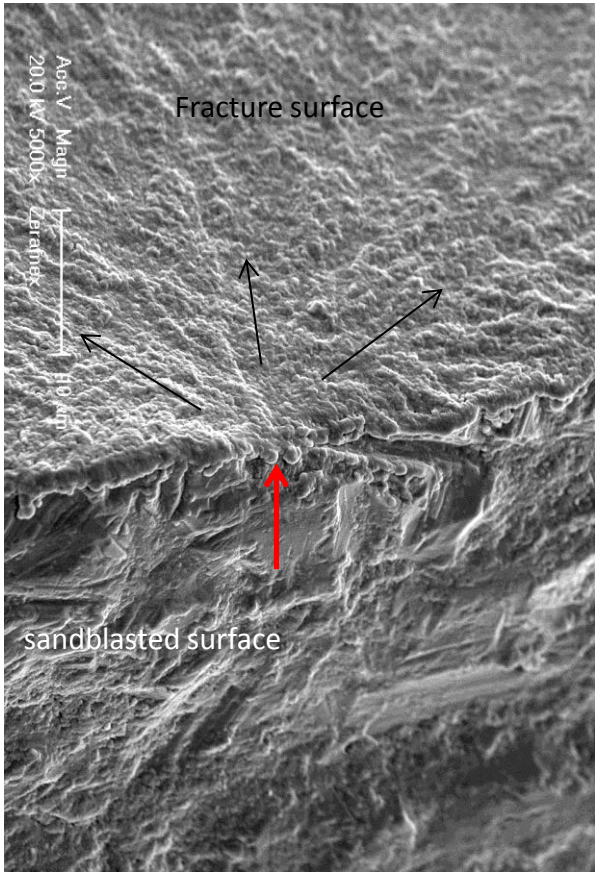
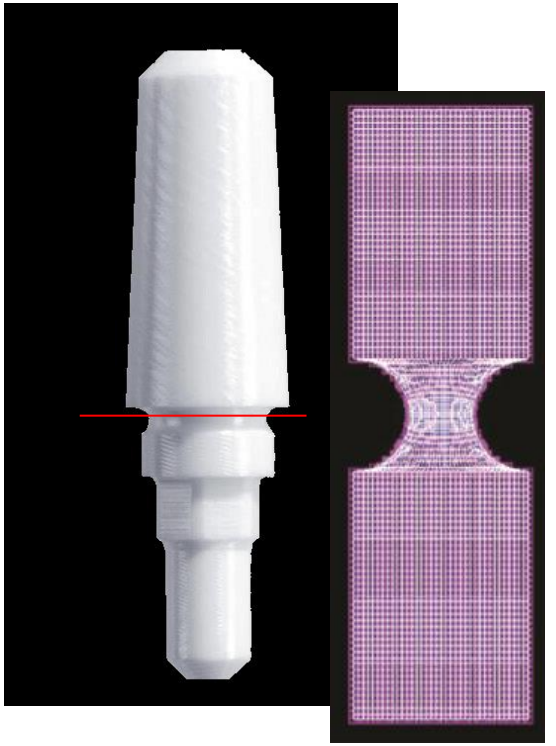
Fractography of clinically failed parts

Implant abutment processing (surface texture) & design issues









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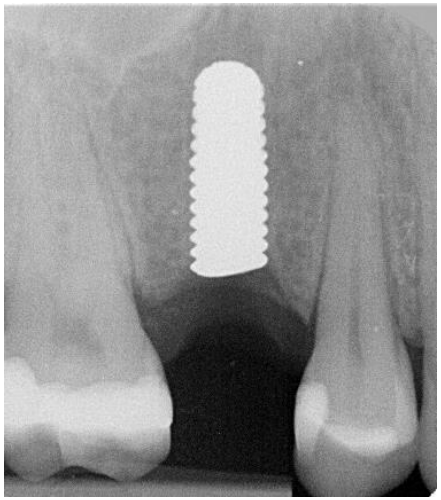
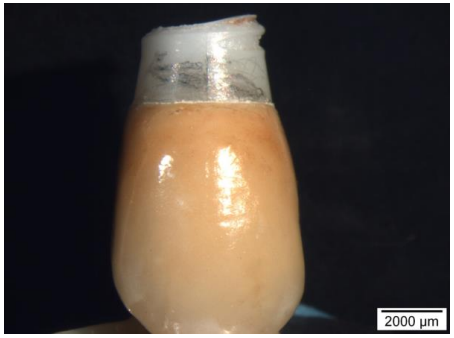
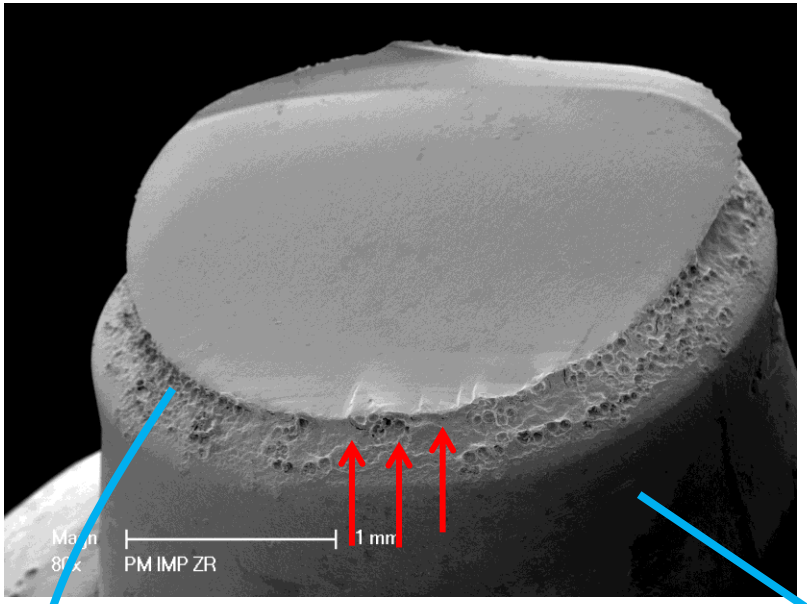
Fractography of clinically failed parts

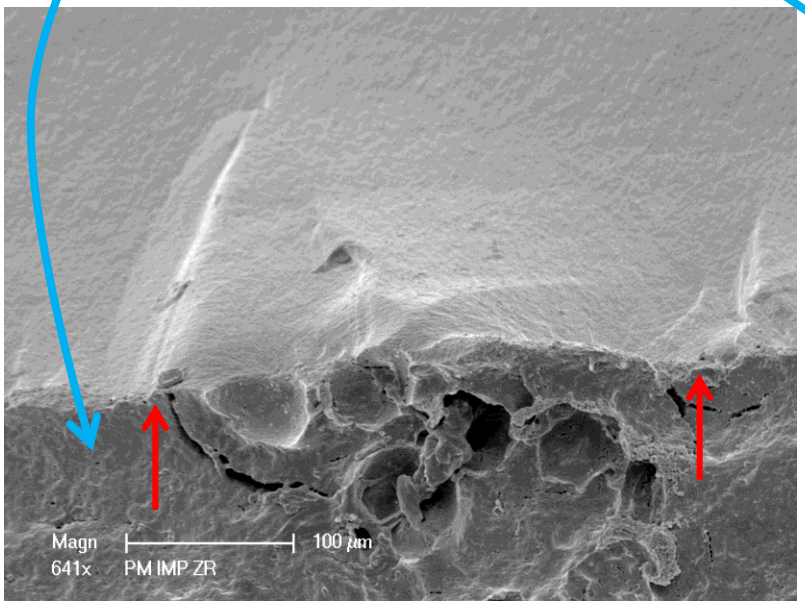
Implant processing issues (surface texture)

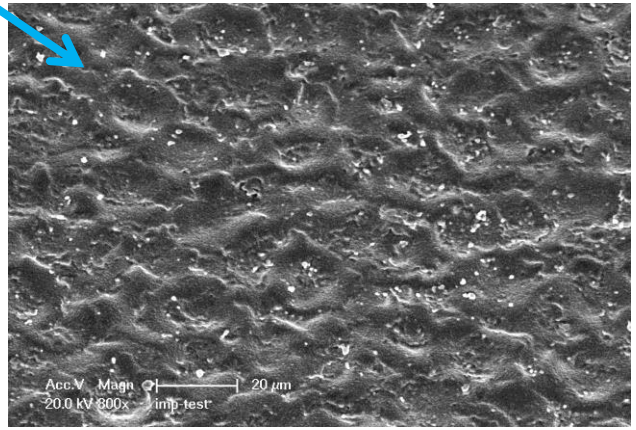




premolar:
failure after
3 months







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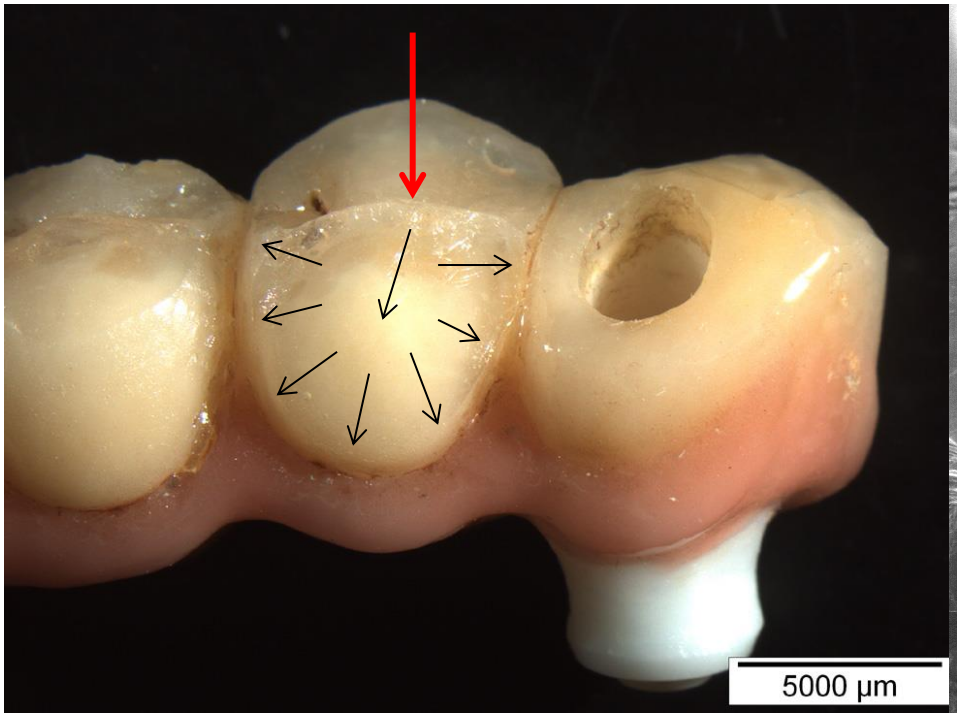
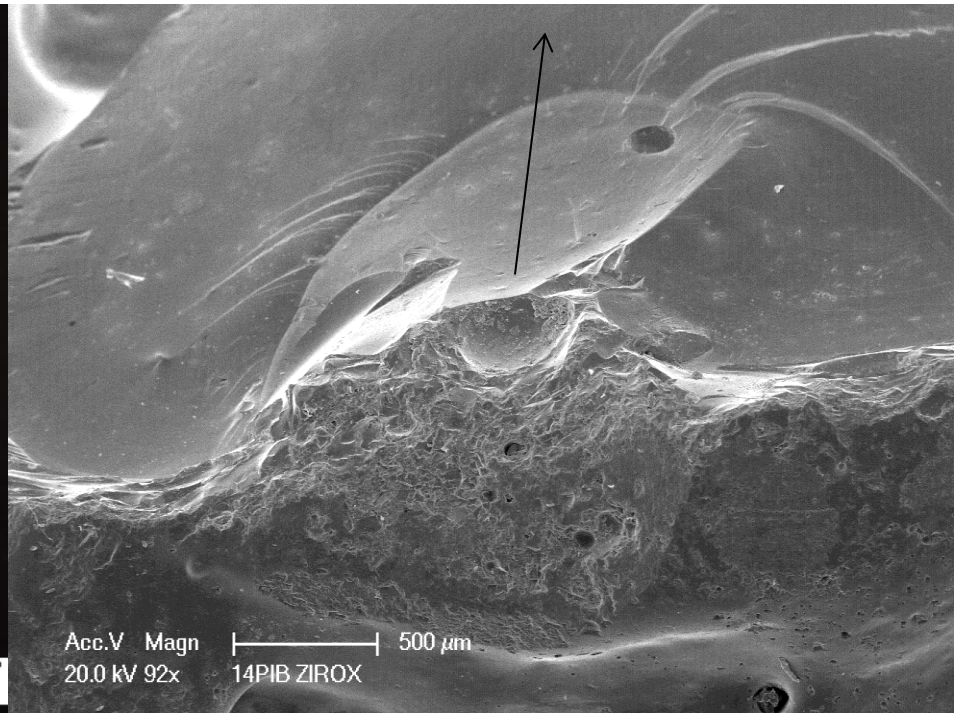
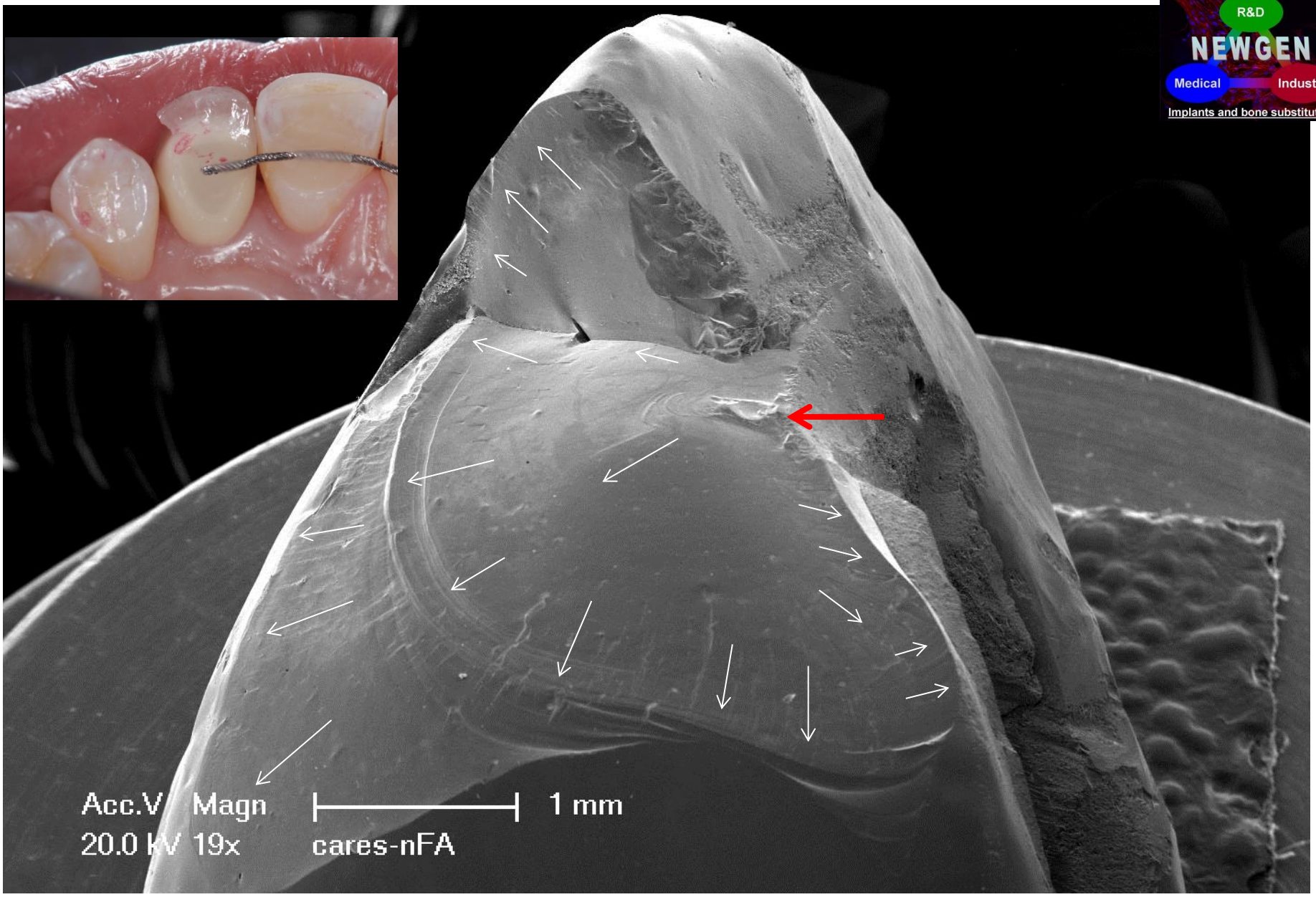
Fractography of clinically failed parts

Occlusal contact damage, surface roughnesses, wear







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Fractography of clinically failed parts

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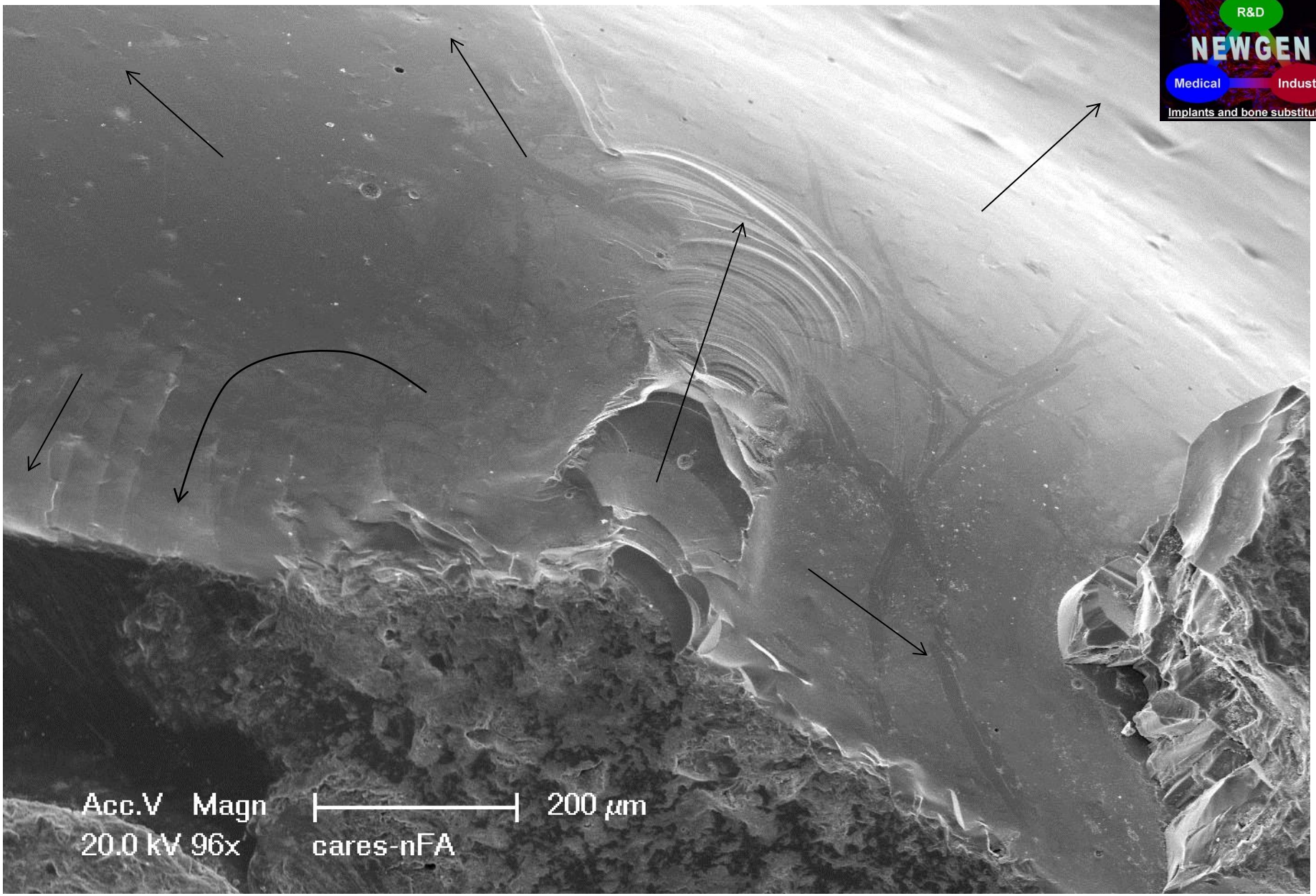

Fractography of clinically failed parts

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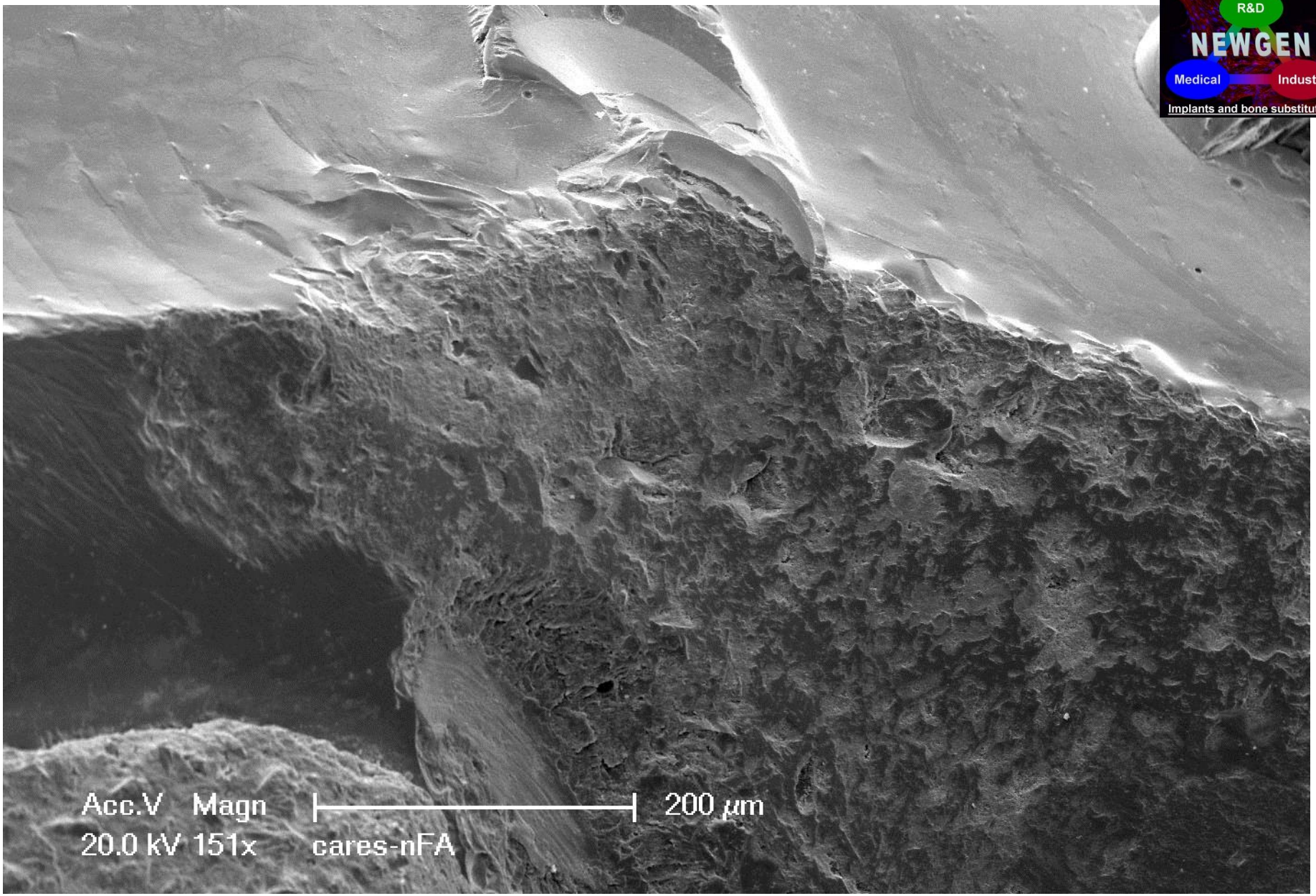

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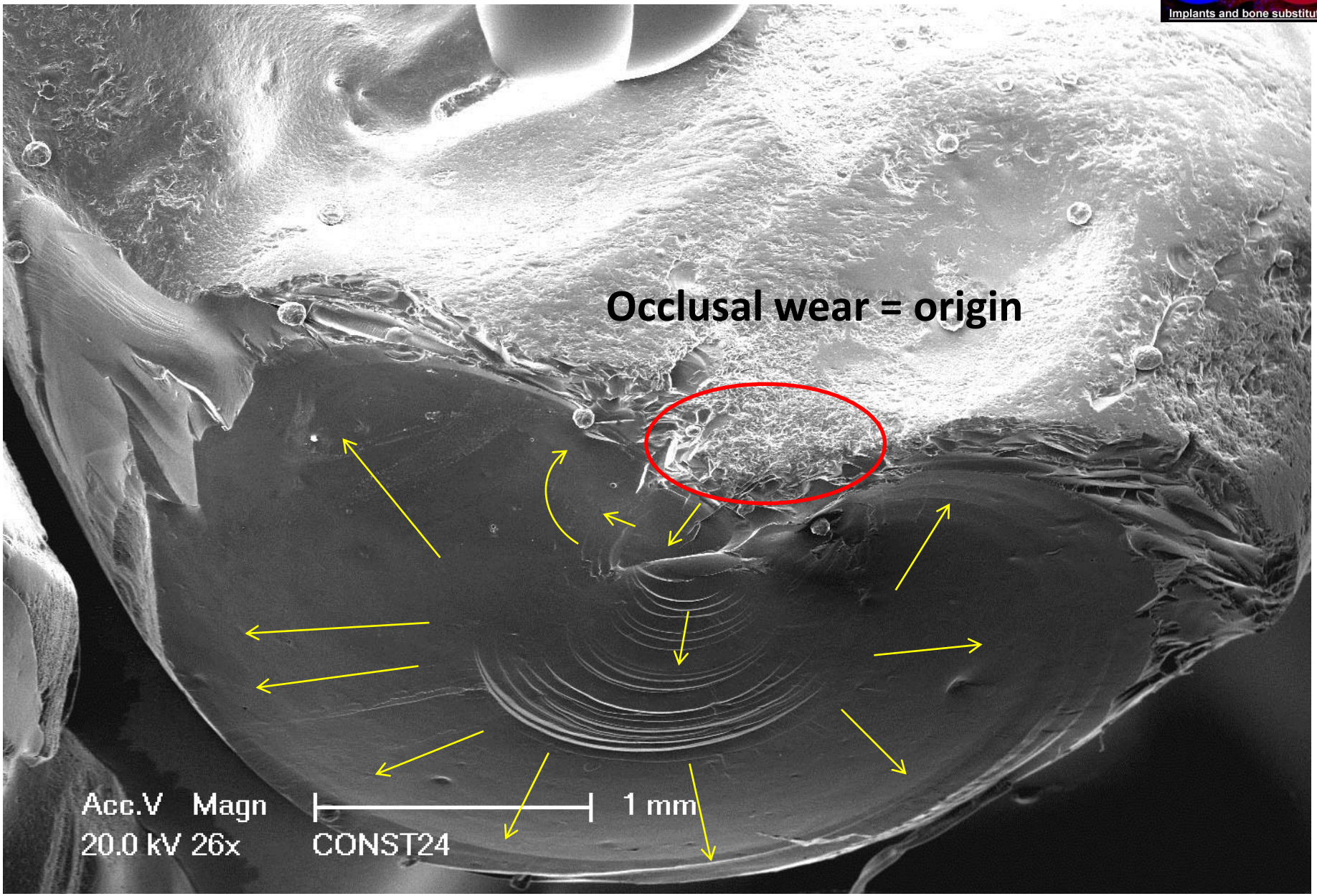
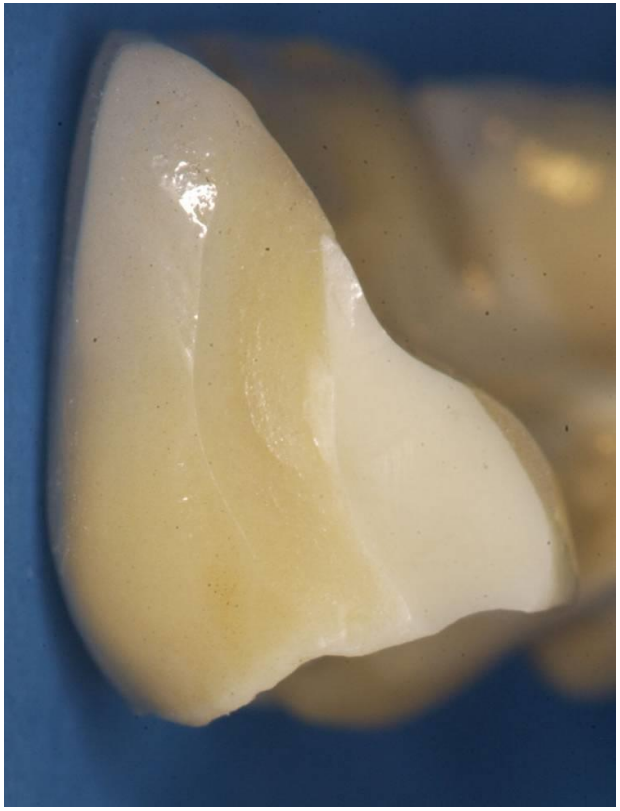
Fractography of clinically failed parts



Fractography of clinically failed parts

Design weakness & processing



Lohbauer, Amberger, Quinn, Scherrer JMBBM; 2010

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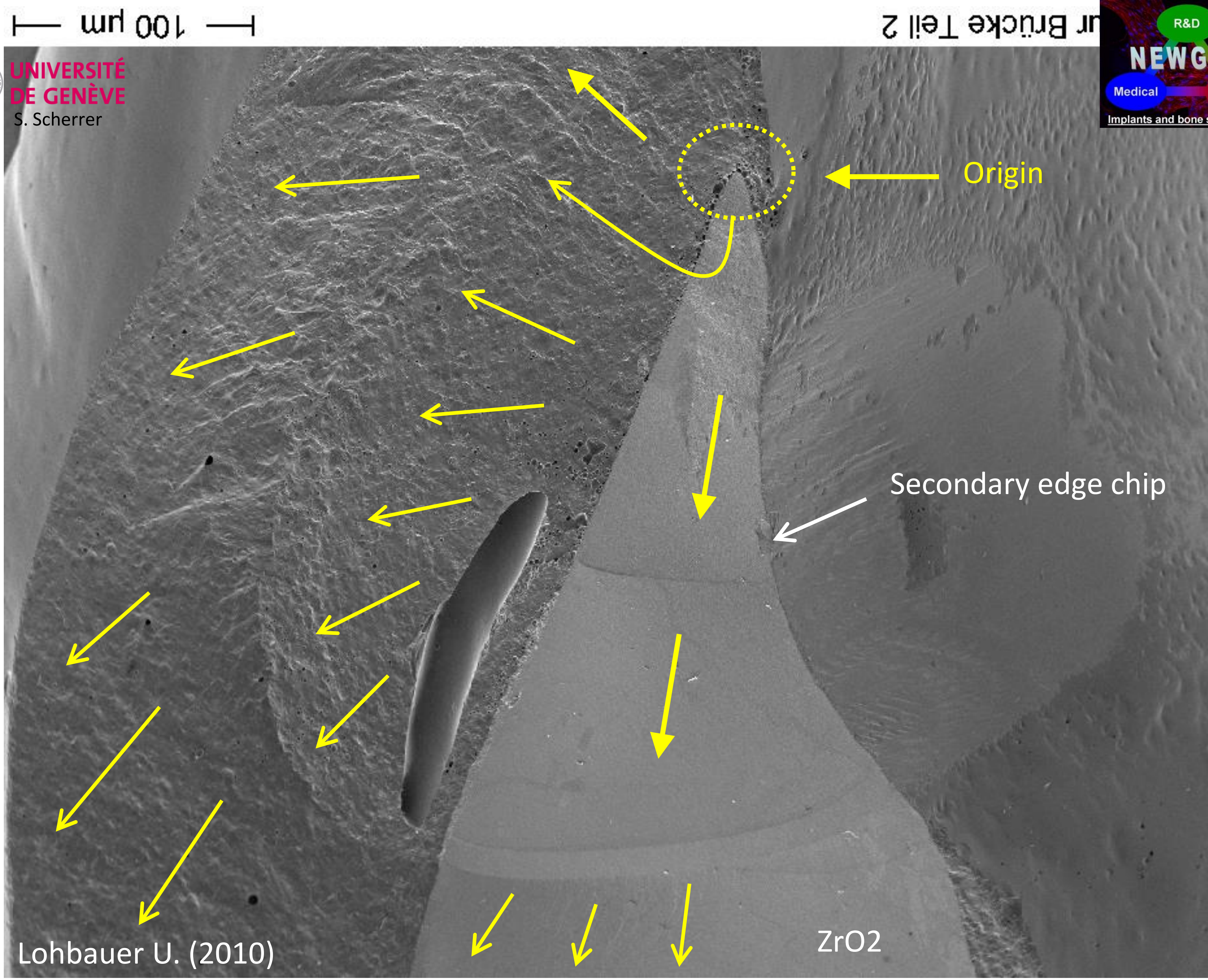

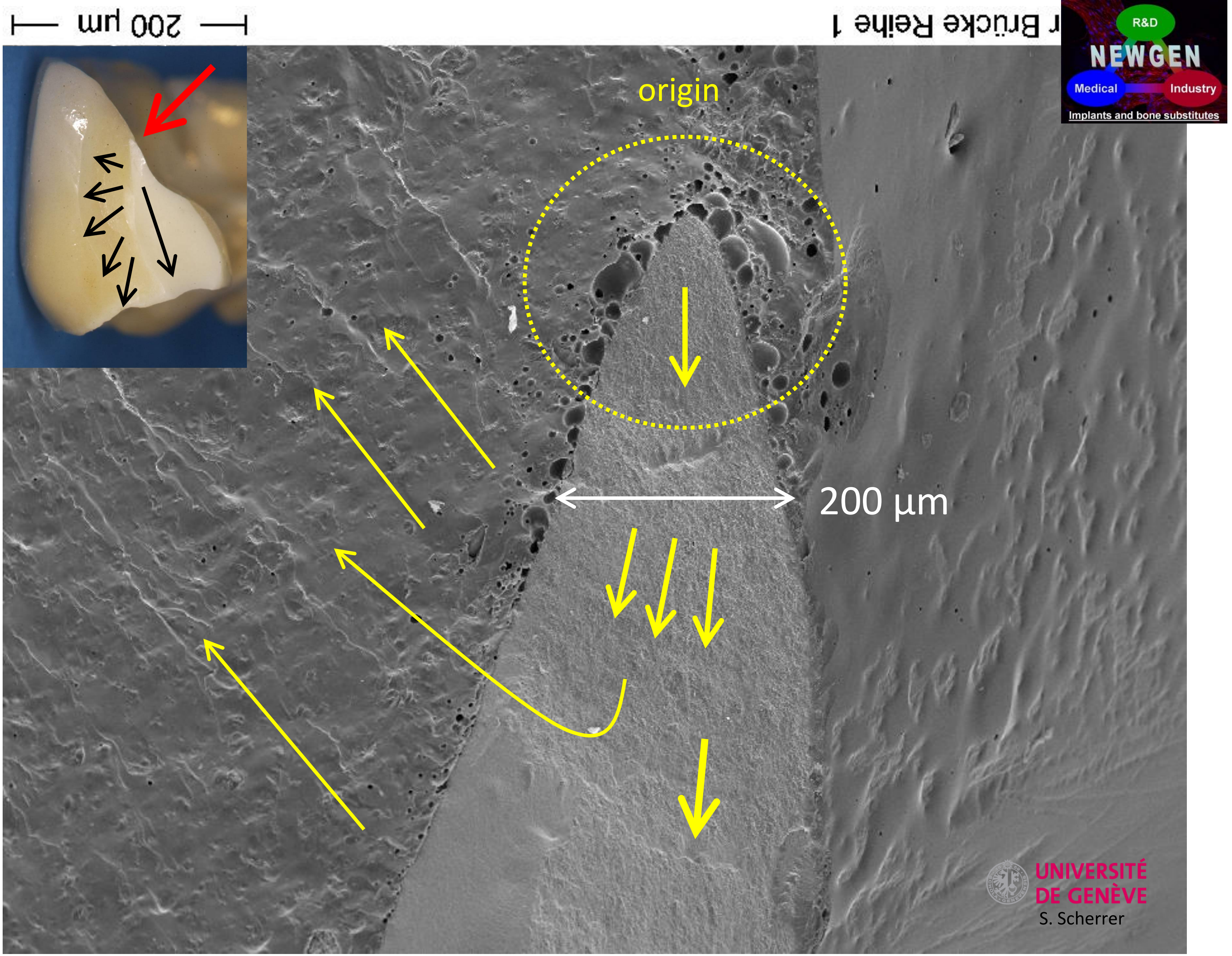
origin
200 µm
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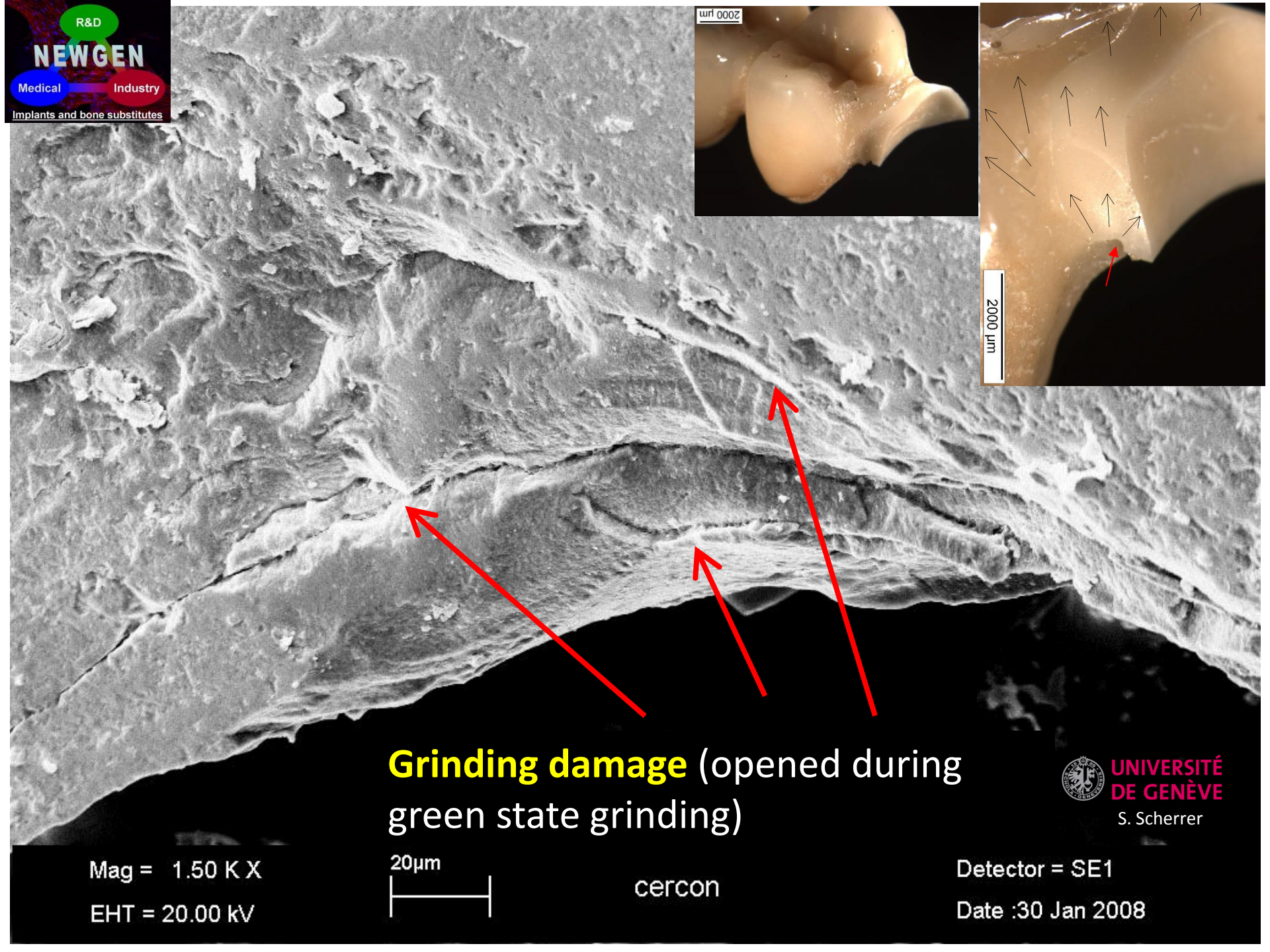
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Industry
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2000 µm
2000 µm
Grinding damage (opened during green state grinding)
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S. Scherrer
Mag = 1.50 K X
EHT = 20.00 kV
20µm
cercon
Detector = SE1
Date :30 Jan 2008

Founders (dec. 2013):
U. Lohbauer, S. Scherrer

FRACTO FORUM INTERNATIONAL

www.fractography.org

R&D NEWGEN Medical Industry
Implants and bone substitutes

Goals:

1. Train clinicians, researchers, industrials to use fractography as a regular tool for failure analysis of brittle materials

2. Identify failure modes in vivo and in vitro of dental ceramics and composites (create a data base)

3. Identify from the failure modes:
    a. weak designs
    b. processing errors
    c. material limitations

4. Dissemination of information / Symposium

The oral environment

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