*Bio-inspired engineering of cellular structures by additive manufacturing **

This version of the presentation has some content removed / covered, due to the work still in process of being published.

Please contact me directly for more information or any questions

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CT FACILITY
STELLENBOSCH

A bit of background first

1. Stellenbosch CT facility – since 2012 a low-cost fast-turnaround microCT service lab

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A bit of background first

1. Stellenbosch CT facility – since 2012 a low-cost fast-turnaround microCT service lab
2. As researcher: this is what I will present today

Outline

“Normal” mechanical analysis by microCT

- Casting porosity – effects of stress around pores on tensile properties

Mechanical analysis of cellular/lattice structures by microCT

- Simulations of design files
- Von Mises stress correlated to failure locations

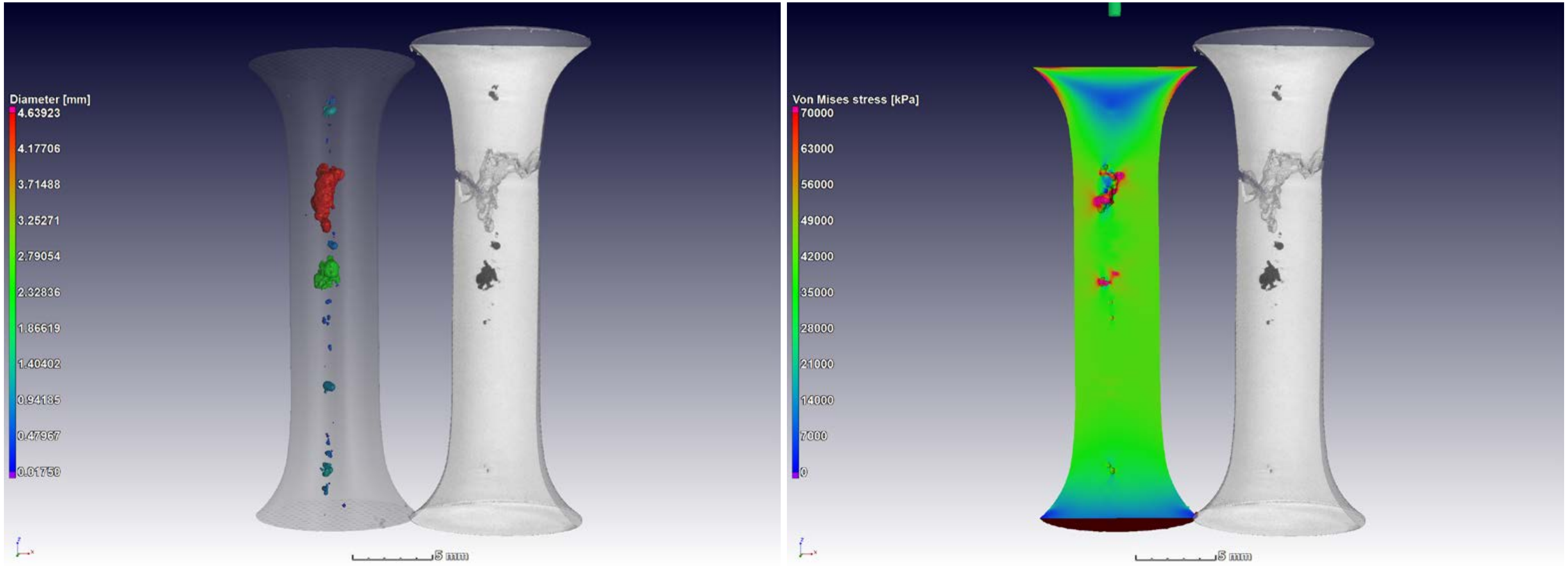
Bio-inspiration & biomechanics using microCT

- Snake fangs
- Dermal plates of lizards
- A special structure for biomimetic cellular design

Additive manufacturing of this special bio-inspired design

Simulations, physical testing & discussion

Mechanical analysis by microCT




Contents lists available at ScienceDirect

Journal of Alloys and Compounds

journal homepage: http://www.elsevier.com/locate/jalcom

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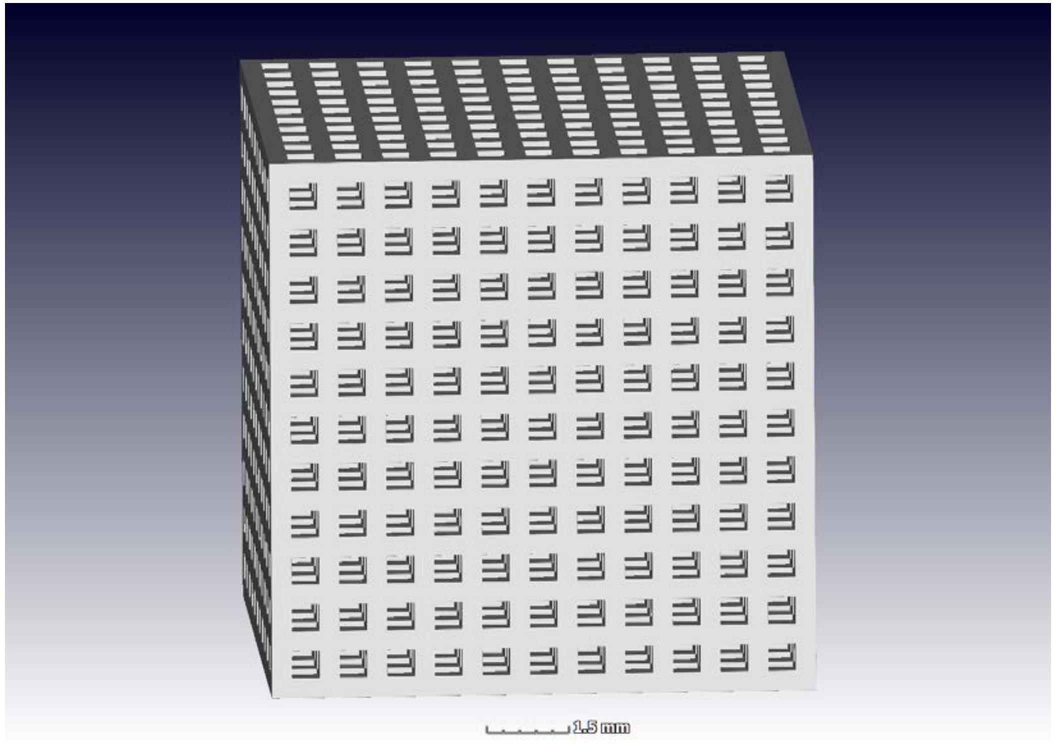
Prediction of mechanical performance of Ti6Al4V cast alloy based on microCT-based load simulation

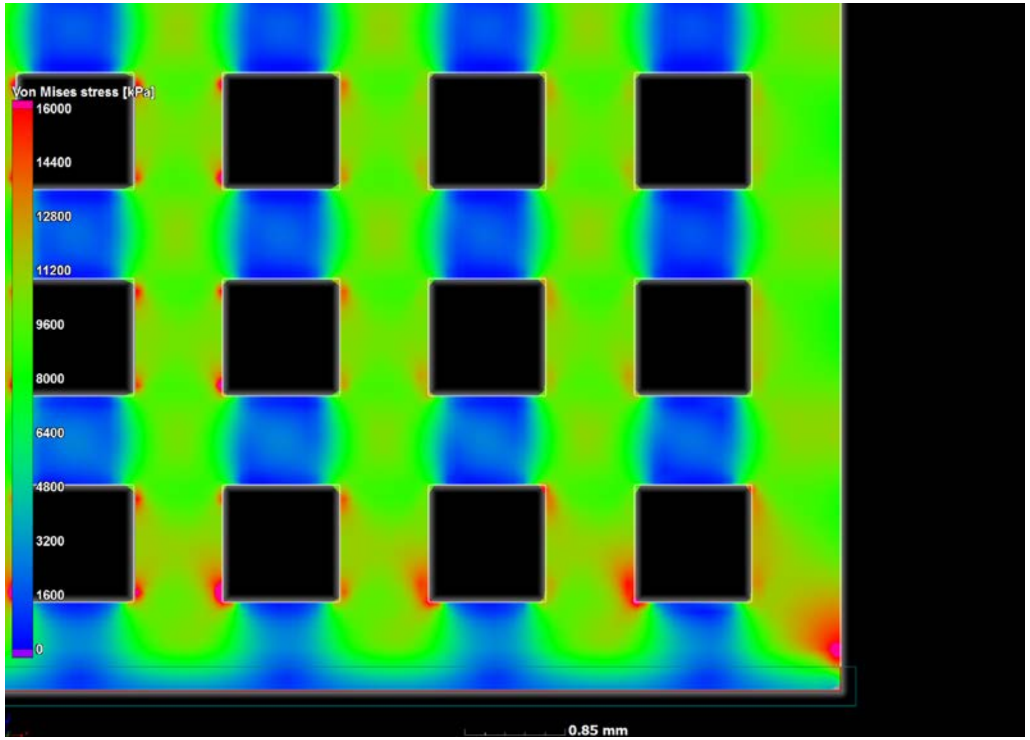
Anton du Plessis [a, *], Ina Yadroitsava [b], Stephan G. le Roux [a], Igor Yadroitsev [b], Johannes Fieres [c], Christof Reinhart [c], Pierre Rossouw [d]

Cellular/lattice structures: lightweight design

* The Spider bracket, a well-known example from Renishaw / Altair / Materialize

Cellular structures: simulations of design files





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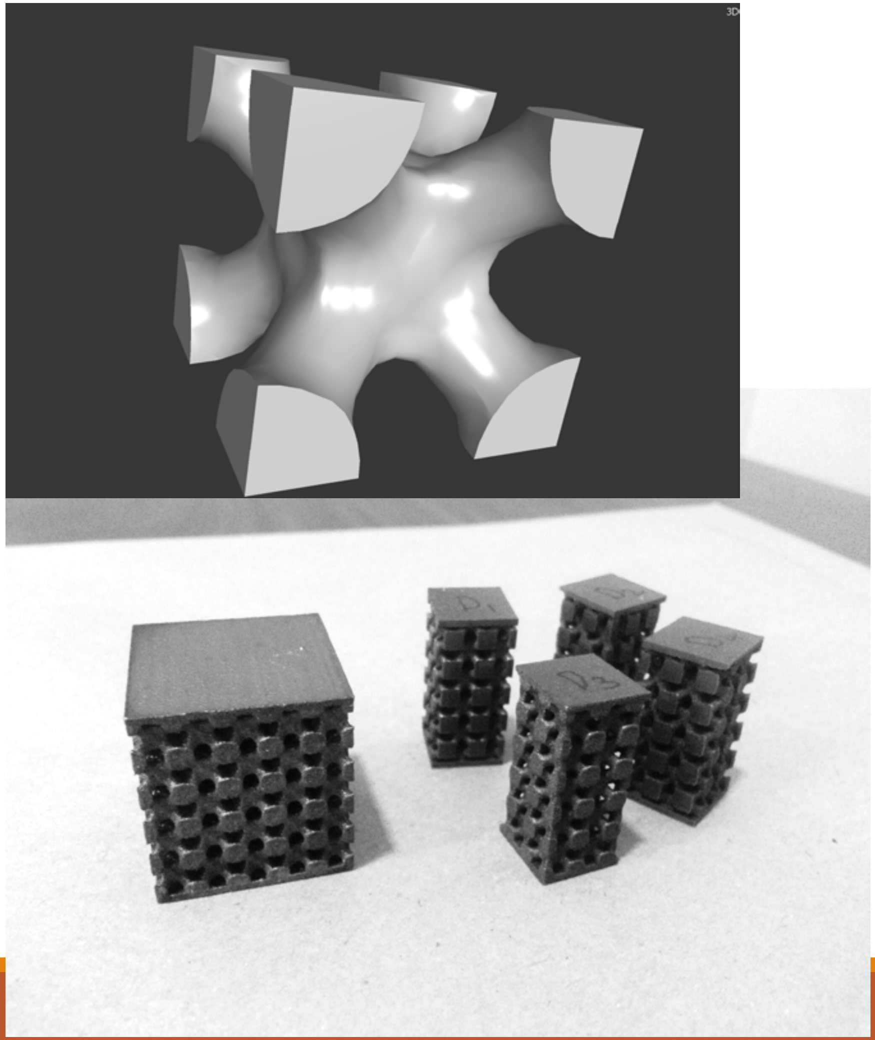
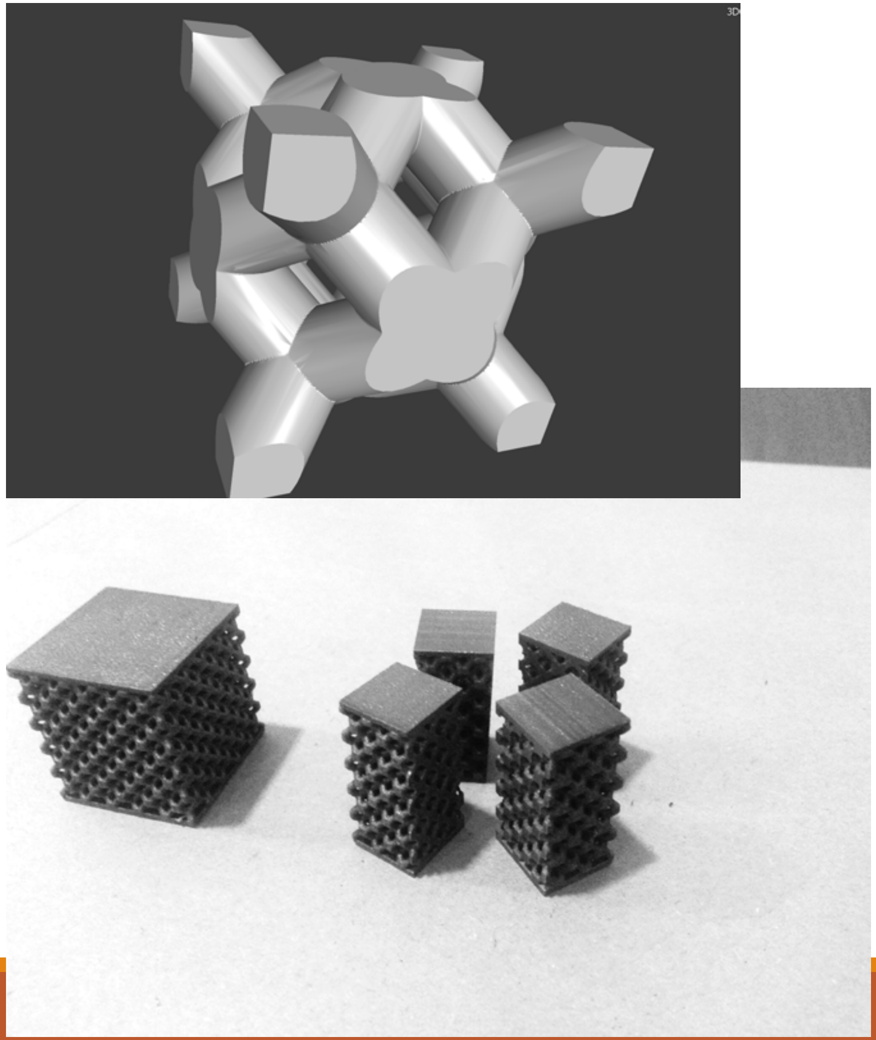
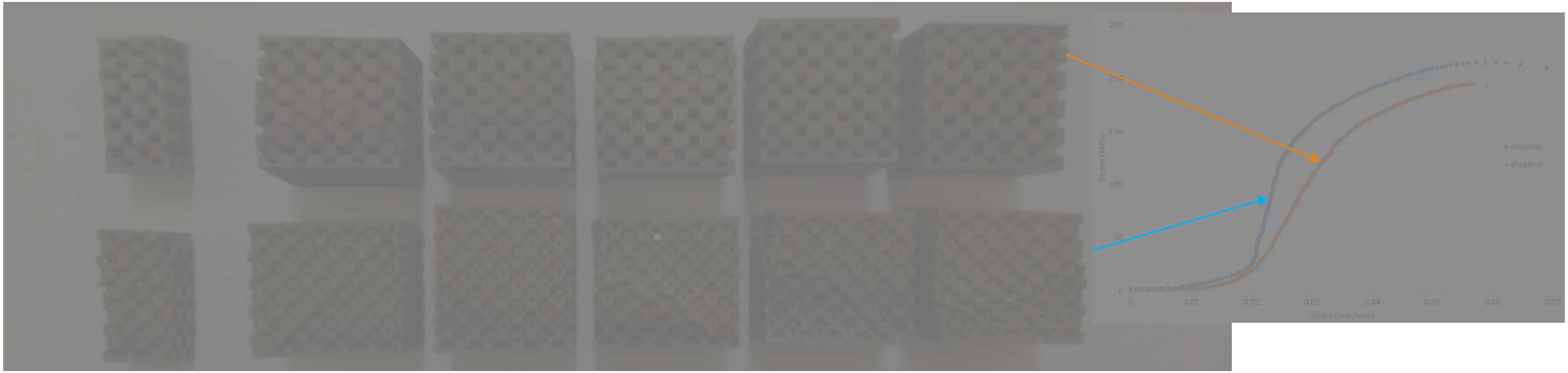
Cellular structures: compare typical designs





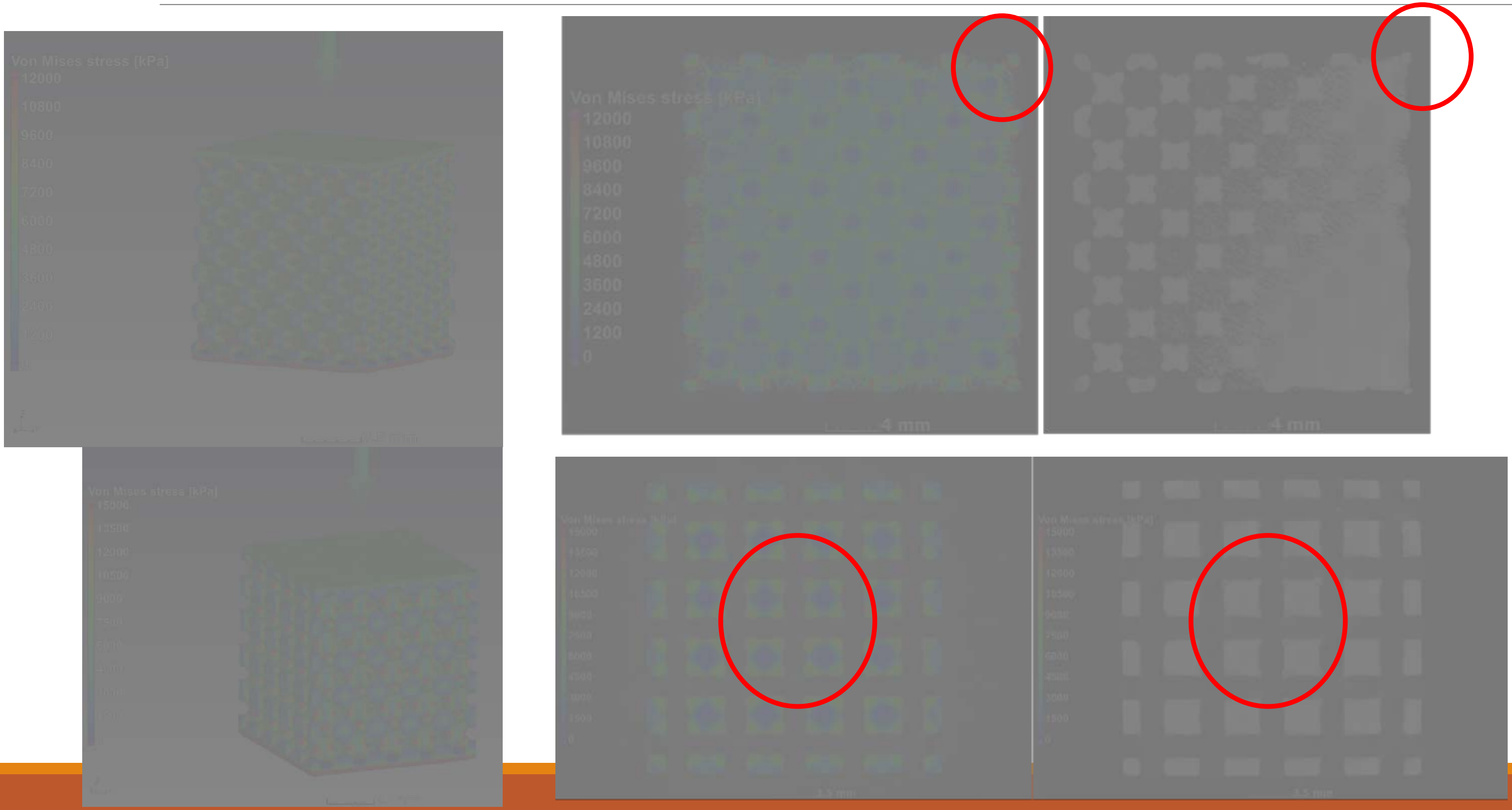
Cellular structures: compare typical designs



25 mm cube: 14 tons of force before failure!

Submitted for publication

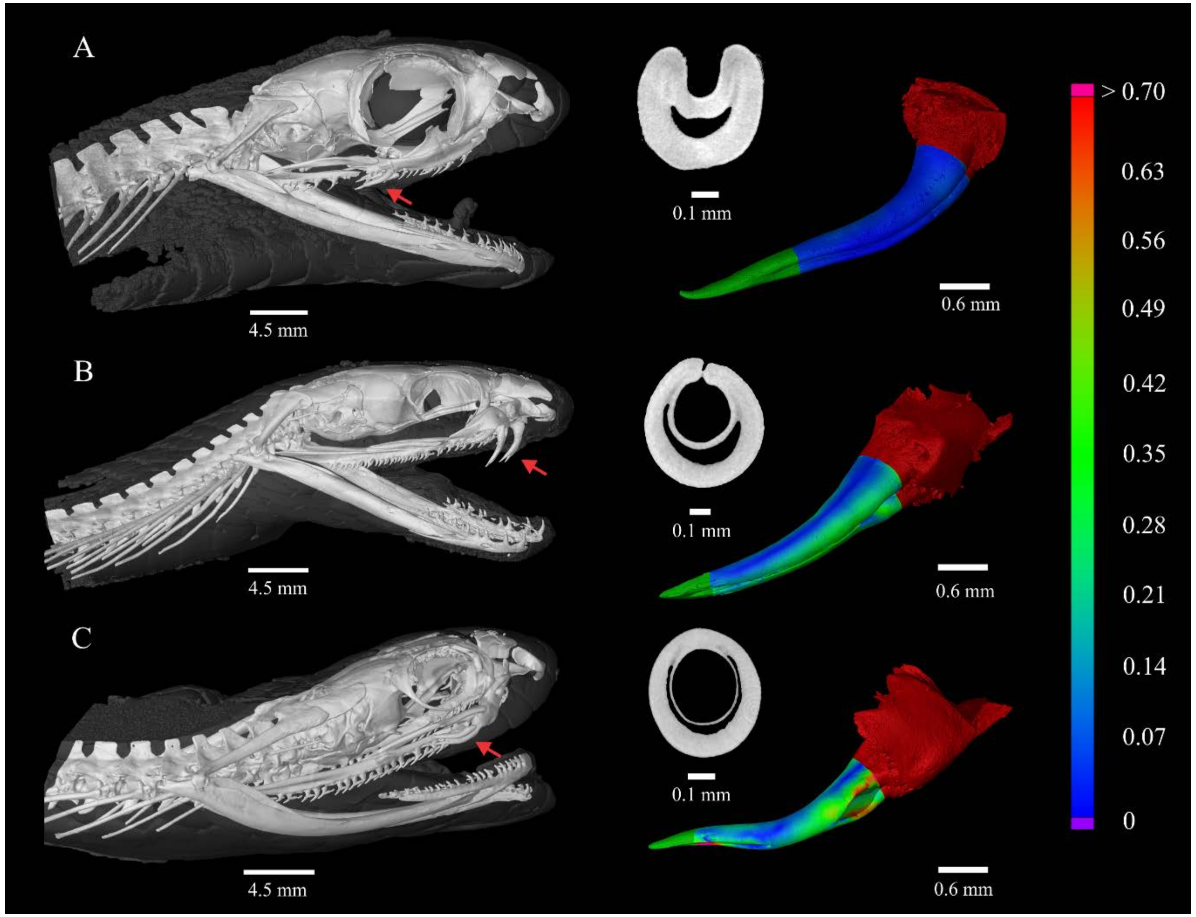
Cellular structures: first failure locations

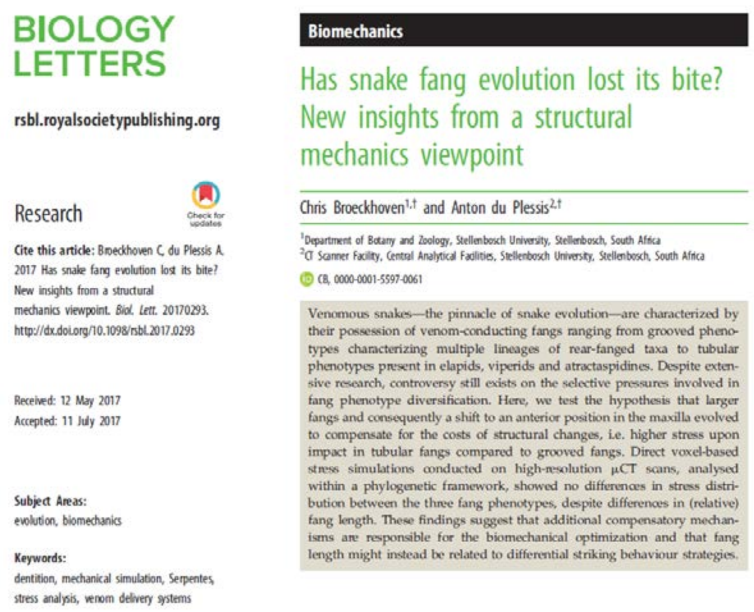


Submitted for publication

Bio-mechanics: example 1

Structural mechanics simulations of snake fangs





BIOLOGY LETTERS

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Research

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evolution, biomechanics

Keywords:
dentition, mechanical simulation, Serpentes, stress analysis, venom delivery systems

Biomechanics

Has snake fang evolution lost its bite? New insights from a structural mechanics viewpoint

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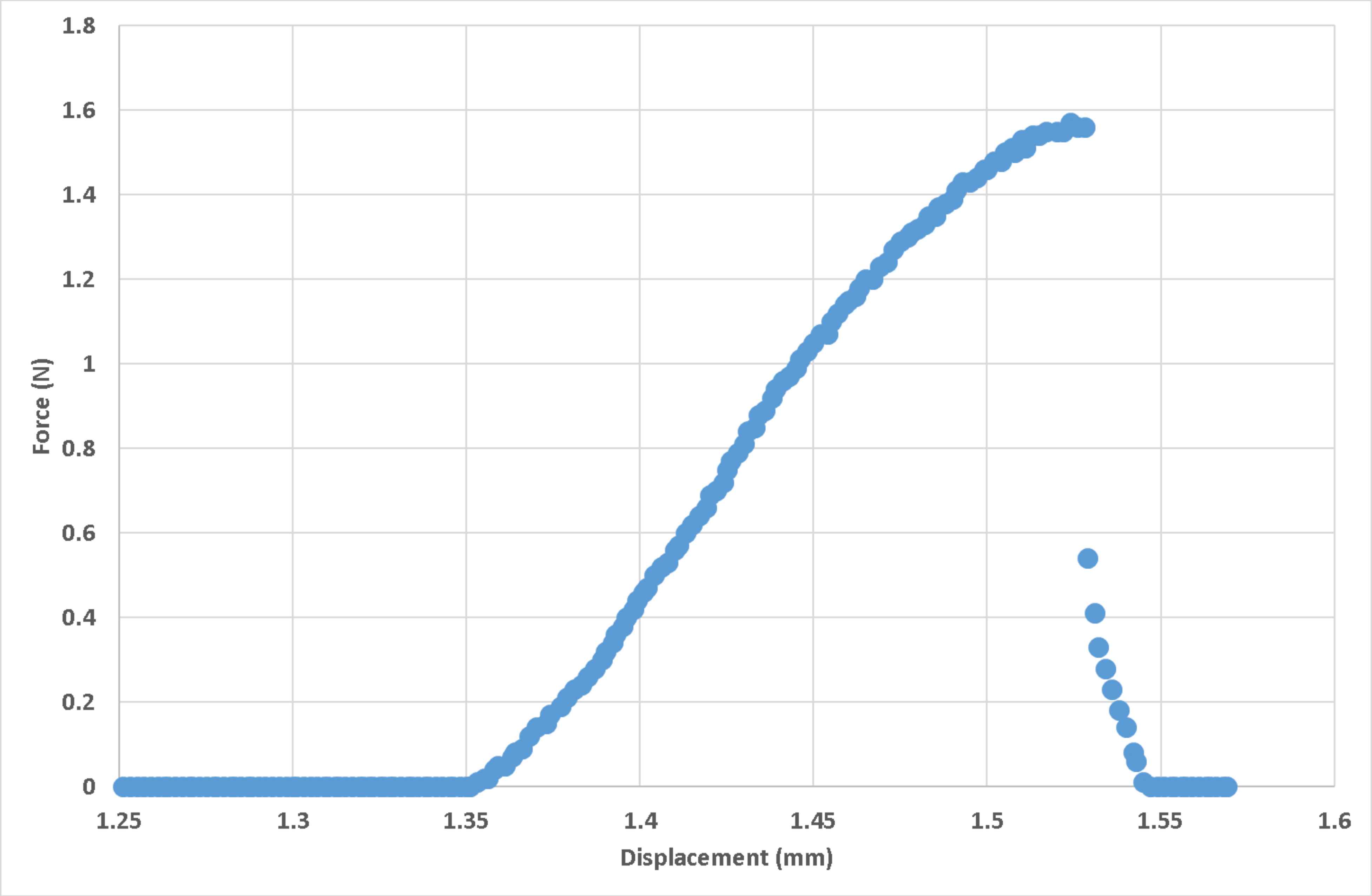
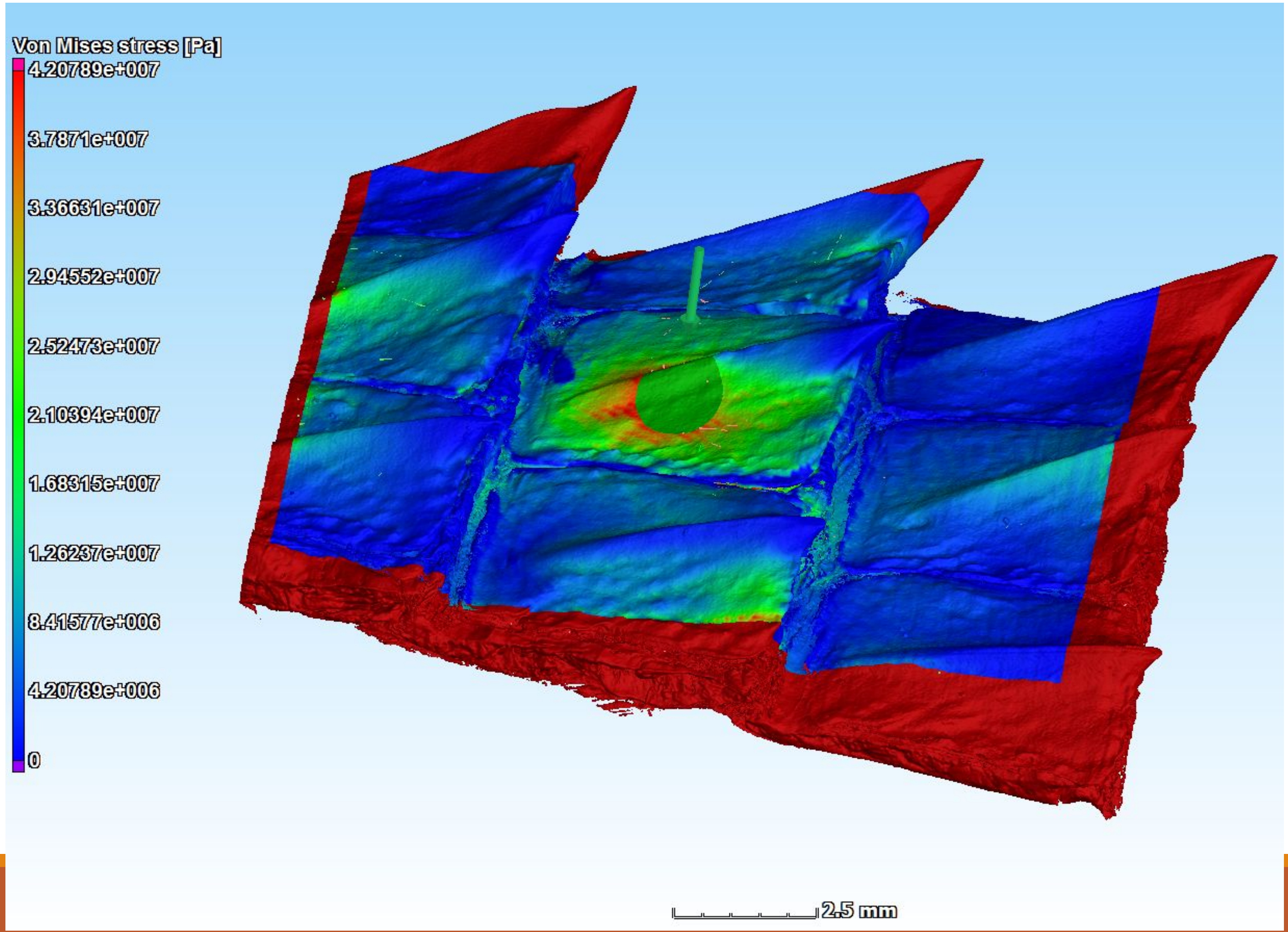
Venomous snakes—the pinnacle of snake evolution—are characterized by their possession of venom-conducting fangs ranging from grooved phenotypes characterizing multiple lineages of rear-fanged taxa to tubular phenotypes present in elapids, viperids and atractaspidines. Despite extensive research, controversy still exists on the selective pressures involved in fang phenotype diversification. Here, we test the hypothesis that larger fangs and consequently a shift to an anterior position in the maxilla evolved to compensate for the costs of structural changes, i.e. higher stress upon impact in tubular fangs compared to grooved fangs. Direct voxel-based stress simulations conducted on high-resolution µCT scans, analysed within a phylogenetic framework, showed no differences in stress distribution between the three fang phenotypes, despite differences in (relative) fang length. These findings suggest that additional compensatory mechanisms are responsible for the biomechanical optimization and that fang length might instead be related to differential striking behaviour strategies.

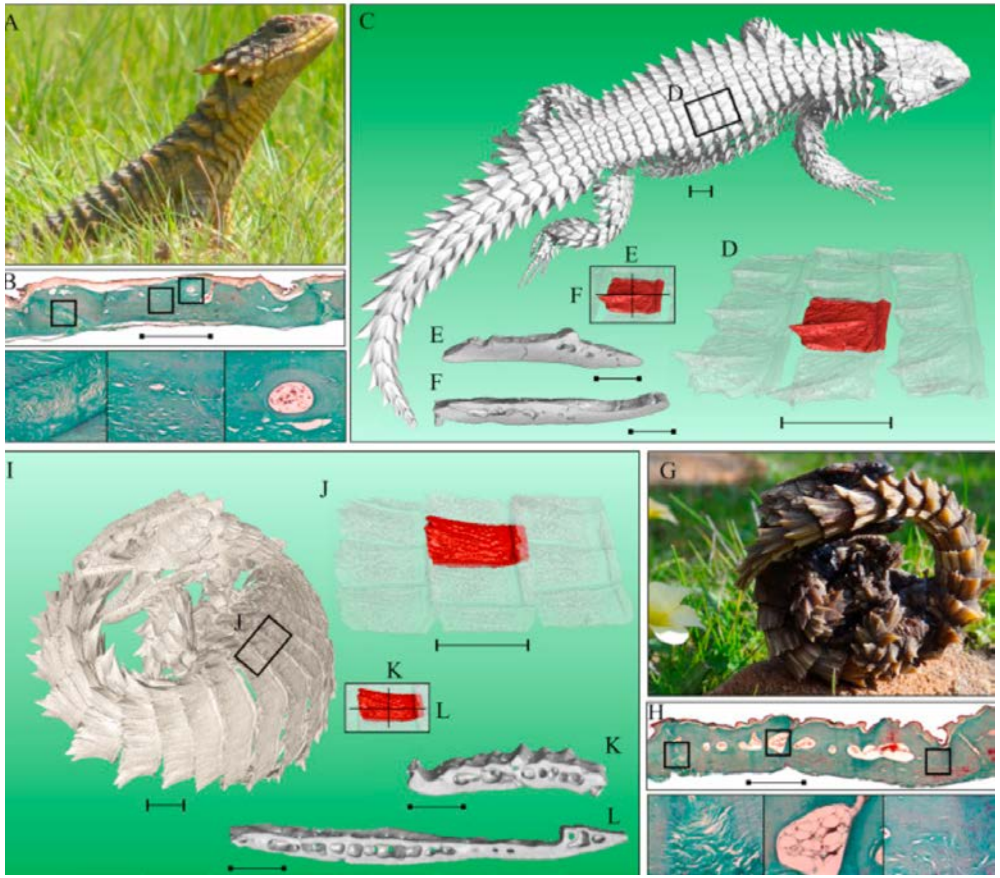
y = 0.0275x-1.334
R² = 0.7094
2.5
2
1.5
1
0.5
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Von Mises stress (10% of maximum)
Radius of fang (mm)
Grooved
Fused
Closed


Force (N)
Displacement (mm)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1.25
1.3
1.35
1.4
1.45
1.5
1.55
1.6

Biomechanics: example 2



Biomechanics: dermal armour of lizards



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Journal of the Mechanical Behavior of Biomedical Materials

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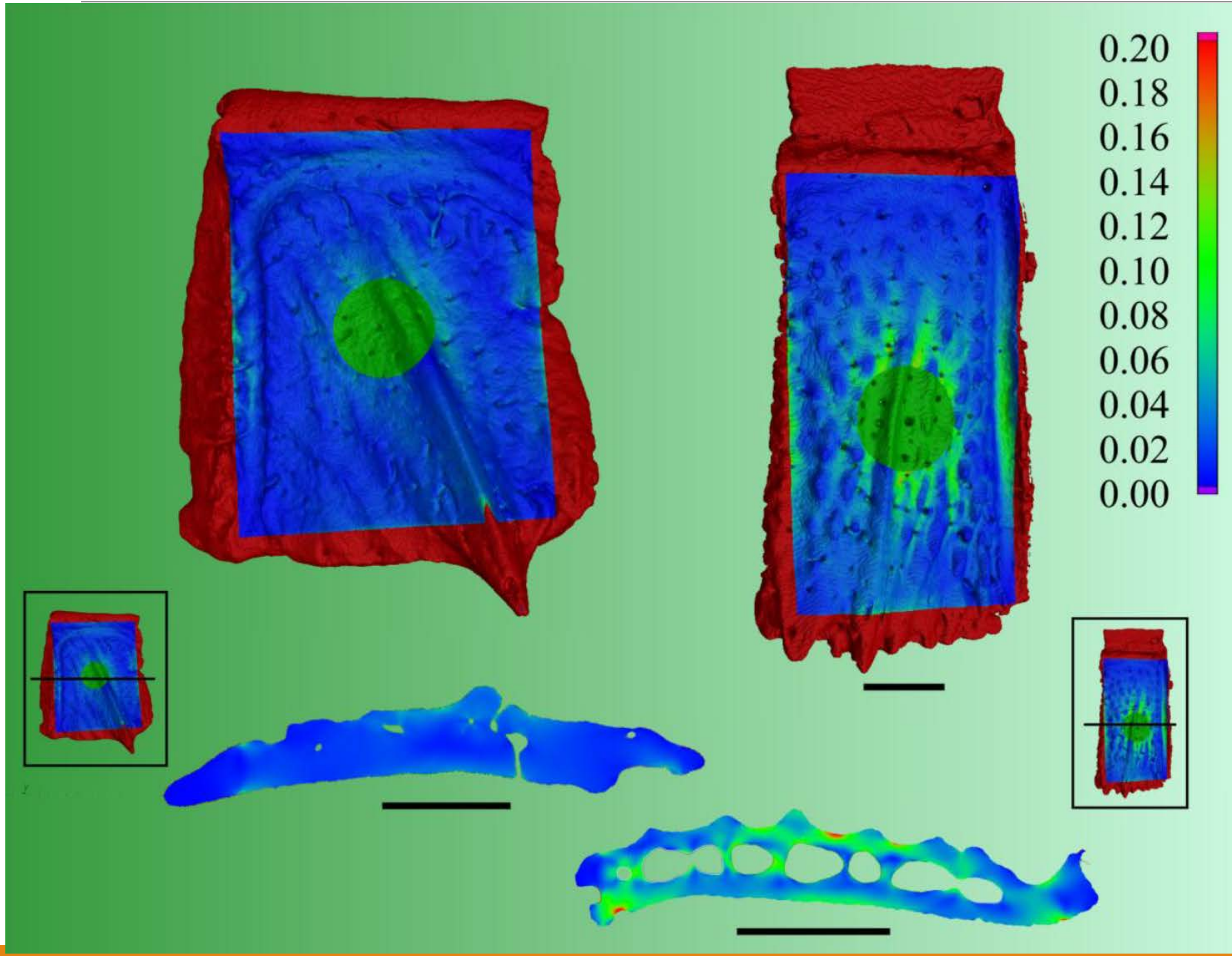
In Press, Accepted Manuscript

Functional trade-off between strength and thermal capacity of dermal armor: insights from girdled lizards

Chris Broeckhoven [a, b], Anton du Plessis [c], Cang Hui [b, d]

Biomechanics: dermal armour of lizards



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