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## 2024

### **Accelerating the remodeling of collagen in cutaneous fullthickness wound using FIR soldering technology with biotargeting nanocomposites hydrogel.**

Chen Y, Chen M, Wang K, Huang J, Gupta HS, He K and Rui Y. *Journal of Biophotonics*. Wiley.

## 2023

### **Is Stress Relaxation in Sea Cucumber Dermis Chemoelastic?.**

Barbieri E and Gupta HS. *Marine Drugs* vol. 21, (12).Mdpi.

### **P08 Dissection of the molecular and cellular heterogeneity of dermal fibroblasts in skin fibrosis.**

Ahmed A, Kirk T, Forster L, O Toole E, Gupta H and Rognoni E. *British Journal of Dermatology* vol. 189, (1) e17-e17. Oxford University Press (Oup).

### **1458 Dissection of the molecular and cellular heterogeneity of dermal fibroblasts in skin fibrosis.**

Ahmed A, Kirk T, Forster L, O'Toole E, Gupta H and Rognoni E. *Journal of Investigative Dermatology* vol. 143, (5). Elsevier.

### **Fast extraction of three-dimensional nanofiber orientation from WAXD patterns using machine learning.**

Sun M, Dong Z, Wu L, Yao H, Niu W, Xu D, Chen P, Gupta HS, Zhang Y, Dong Y, Chen C and Zhao L. *Iucrj* vol. 10, (Pt 3) 297-308. International Union of Crystallography (Iucr).

## 2022

### **Collagen pre-strain discontinuity at the boneCartilage interface.**

Badar W, Ali H, Brooker ON, Newham E, Snow T, Terrill NJ, Tozzi G, Fratzl P, Knight MM and Gupta HS. *Plos One* vol. 17, (9).Public Library of Science (Plos).

### **Chemoviscoelasticity of the interfibrillar matrix of the dermis of the black sea cucumber Holothuria atria.**

Barbieri E, Mo J and Gupta HS. *Mechanics of Materials* vol. 168,.Elsevier.

### **In situ determination of the extreme damage resistance behavior in stomatopod dactyl club.**

Dong Z, Chen S, Gupta HS, Zhao X, Yang Y, Chang G, Xue J, Zhang Y, Luo S, Dong Y and Zhang Y. *Journal of Synchrotron Radiation* vol. 29, (3) 775-786. International Union of Crystallography (Iucr).

### **Investigating the Fibrillar Ultrastructure and Mechanics in Keloid Scars Using In Situ Synchrotron X-ray Nanomechanical Imaging.**

Zhang Y, Hollis D, Ross R, Snow T, Terrill NJ, Lu Y, Wang W, Connelly J, Tozzi G and Gupta HS. *Materials (Basel)* vol. 15, (5).Mdpi.

### **Effect of interphase boundaries on nanoindentation experiments on a Ni-base alloy.**

Schberl T and Gupta HS. *International Journal of Materials Research (Formerly Zeitschrift Fuer Metallkunde)* vol. 94, (7) 813-818.

## 2021

### Precipitate Size Distribution in Alloys with and without Lattice Misfit.

Weinkamer R, Gupta H, Lebowitz JL and Fratzl P. *International Journal of Materials Research vol. 92, (1) 9-13.*

### Reversible changes in the 3D collagen fibril architecture during cyclic loading of healthy and degraded cartilage.

Inamdar SR, Prévost S, Terrill NJ, Knight MM and Gupta HS. *Acta Biomaterialia vol. 136, 314-326. Elsevier.*

### The Mutable Collagenous Tissue of Echinoderms: From Biology to Biomedical Applications.

Elphick M. *Soft Matter For Biomedical Applications. Royal Society of Chemistry.*

### Separating effects of bone-quality changes at multiple scales in steroid-induced osteoporosis: Combining multiscale experimental and modelling approaches.

Xi L, Barbieri E, Wang P, Wu W and Gupta H. *Mechanics of Materials vol. 157,. Elsevier.*

### Tomographic Xray scattering based on invariant reconstruction: analysis of the 3D nanostructure of bovine bone.

De Falco P, Weinkamer R, Wagermaier W, Li C, Snow T, Terrill NJ, Gupta HS, Goyal P, Stoll M, Benner P and Fratzl P. *Journal of Applied Crystallography vol. 54, (2) 486-497. International Union of Crystallography (Iucr).*

### Activation of TRPV4 by mechanical, osmotic or pharmaceutical stimulation is anti-inflammatory blocking IL-1 mediated articular cartilage matrix destruction.

Fu S, Meng H, Inamdar S, Das B, Gupta H, Wang W, Thompson C and Knight M. *Osteoarthritis and Cartilage. Block JA. Elsevier.*

### Chapter 2 Synchrotron X-ray Imaging Combined with Multiscale Modeling Applied to Biological Soft Tissues.

Gupta HS, Barbieri E, Inamdar SR and Mo J. *Soft Matter For Biomedical Applications 34-60. Royal Society of Chemistry (Rsc).*

## 2020

### Molecular to Macroscale Energy Absorption Mechanisms in Biological Body Armour Illuminated by Scanning X-ray Diffraction with In Situ Compression.

Zhang Y, Garrevoet J, Wang Y, Roeh JT, Terrill NJ, Falkenberg G, Dong Y and Gupta HS. *Acs Nano. American Chemical Society.*

### A multiscale study of structural and compositional changes in a natural nanocomposite: Osteoporotic bone with chronic endogenous steroid excess.

Xi L, Zhang Y, Gupta H, Terrill N, Wang P, Zhao T and Fang D. *Bone vol. 143,. Elsevier.*

## 2019

### Reduction of fibrillar strain-rate sensitivity in steroid-induced osteoporosis linked to changes in mineralized fibrillar nanostructure.

Xi L, De Falco P, Barbieri E, Karunaratne A, Bentley L, Esapa CT, Davis GR, Terrill NJ, Cox RD, Pugno NM, Thakker RV, Weinkamer R, Wu WW, Fang DN and Gupta HS. *Bone vol. 131,. Elsevier.*

### Matrix-induced pre-strain and mineralization-dependent interfibrillar shear transfer enable 3D fibrillar deformation in a biogenic armour.

Wang Y, Zhang Y, Terrill NJ, Barbieri E, Pugno NM and Gupta HS. *Acta Biomaterialia. Elsevier.*

### Proteoglycan degradation mimics static compression by altering the natural gradients in fibrillar organisation in cartilage.

Inamdar SR, Barbieri E, Terrill NJ, Knight MM and Gupta HS. *Acta Biomaterialia vol. 97, 437-450. Elsevier.*

## 2018

### Multilayer stag beetle elytra perform better under external loading via non-symmetric bending properties.

Kundanati L, Signetti S, Gupta HS, Menegon M and Pugno NM. *J R Soc Interface vol. 15, (144).*

**Bone matrix development in steroid-induced osteoporosis is associated with a consistently reduced fibrillar stiffness linked to altered bone mineral quality.**

Xi L, De Falco P, Barbieri E, Karunaratne A, Bentley L, Esapa CT, Terrill NJ, Brown SDM, Cox RD, Davis GR, Pugno NM, Thakker RV and Gupta HS. *Acta Biomaterialia* vol. 76, 295-307. Elsevier.

**Unlocking the secrets of mutable collagenous tissue.**

Gupta HS, Szulgit G, Elphick MR and Mo J. *Biochemist* vol. 40, (1) 8-11.

## 2017

**The Secret Life of Collagen: Temporal Changes in Nanoscale Fibrillar Pre-Strain and Molecular Organization During Physiological Loading of Cartilage.**

Inamdar SR, Knight DP, Terrill NJ, Karunaratne A, Cacho-Nerin F, Knight MM and Gupta HS. *Acs Nano*.

**Towards in situ determination of 3D strain and reorientation in the interpenetrating nanofibre networks of cuticle.**

Zhang Y, De Falco P, Wang Y, Barbieri E, Paris O, Terrill NJ, Falkenberg G, Pugno NM and Gupta HS. *Nanoscale*.

**Body wall structure in the starfish *Asterias rubens*.**

Blowes LM, Egertova M, Liu Y, Davis GR, Terrill NJ, Gupta HS and ELPHICK MR. *Journal of Anatomy*. Wiley.

**Staggered Fibrils and Damageable Interfaces Lead Concurrently and Independently to Hysteretic Energy Absorption and Inhomogeneous Strain Fields in Cyclically Loaded Antler Bone.**

De Falco P, Barbieri E, Pugno N and Gupta HS. *Acs Biomaterials Science & Engineering*.

## 2016

**Structural Building Blocks of Soft Tissues: Tendons and Heart Valves.**

Gupta HS and Screen HRC. *Material Parameter Identification and Inverse Problems in Soft Tissue Biomechanics* 1-35. Springer Nature.

**Interfibrillar stiffening of echinoderm mutable collagenous tissue demonstrated at the nanoscale.**

Mo J, Prévost SF, Blowes LM, Egertov M, Terrill NJ, Wang W, Elphick MR and Gupta HS. *Proc Natl Acad Sci U S A*.

**Uncovering three-dimensional gradients in fibrillar orientation in an impact-resistant biological armour.**

Zhang Y, Paris O, Terrill NJ and Gupta HS. *Scientific Reports* vol. 6, 26249-26249. Nature Publishing Group: Open Access Journals - Option C.

## 2015

**Multiscale alterations in bone matrix quality increased fragility in steroid induced osteoporosis.**

Karunaratne A, Xi L, Bentley L, Sykes D, Boyde A, Esapa CT, Terrill NJ, Brown SDM, Cox RD, Thakker RV and Gupta HS. *Bone* vol. 84, 15-24. Elsevier.

**Naturally inspired polyelectrolyte multilayer composite films synthesised through layer-by-layer assembly and chemically infiltrated with CaCO<sub>3</sub>.**

Patel IF, Kiryukhin MV, Yakovlev NL, Gupta HS and Sukhorukov GB. *Journal of Materials Chemistry B* vol. 3, (24) 4821-4830. Royal Society of Chemistry (Rsc).

## 2014

**Integrative and comparative analysis of coiled-coil based marine snail egg cases - A model for biomimetic elastomers.**

Guerette PA, Z. Tay G, Hoon S, Loke JJ, Hermawan AF, Schmitt CNZ, Harrington MJ, Masic A, Karunaratne A, Gupta HS, Tan KS, Schwaighofer A, Nowak C and Miserez A. *Biomaterials Science* vol. 2, (5) 710-722.

## 2013

**Nanointerfacial strength between non-collagenous protein and collagen fibrils in antler bone.**

Hang F, Gupta HS and BARBER AH. *Journal of The Royal Society Interface* vol. 11, (92). Royal Society Publishing.

**Intrafibrillar plasticity through mineral/collagen sliding is the dominant mechanism for the extreme toughness of antler bone.**

Gupta HS, Krauss S, Kerschnitzki M, Karunaratne A, Dunlop JWC, Barber AH, Boesecke P, Funari SS and Fratzl P. *Journal of The Mechanical Behavior of Biomedical Materials* vol. 28, 366-382.

**Symmetrically reduced stiffness and increased extensibility in compression and tension at the mineralized fibrillar level in rachitic bone.**

Karunaratne A, Boyde A, Esapa CT, Hiller J, Terrill NJ, Brown SDM, Cox RD, Thakker RV and Gupta HS. *Bone* vol. 52, (2) 689-698.

**Synchrotron X-ray nanomechanical imaging of mineralized fiber composites.**

Karunaratne A, Terrill NJ and Gupta HS. *Methods Enzymol* vol. 532, 415-473.

## 2012

**Pseudoelastic behaviour of a natural material is achieved via reversible changes in protein backbone conformation.**

Harrington MJ, Wasko SS, Masic A, Fischer FD, Gupta HS and Fratzl P. *Journal of The Royal Society Interface* vol. 9, (76) 2911-2922.

**Hypophosphatemic rickets is associated with disruption of mineral orientation at the nanoscale in the flat scapula bones of rachitic mice with development.**

Karunaratne A, Davis GR, Hiller J, Esapa CT, Terrill NJ, Brown SDM, Cox RD, Thakker RV and Gupta HS. *Bone* vol. 51, (3) 553-562.

**Recording IR spectra for individual electrospun fibers using an in situ AFM-synchrotron technique.**

Stachewicz U, Hang F, Bailey RJ, Gupta HS, Frogley MD, Cinque G and Barber AH. *Materials Research Society Symposium Proceedings* vol. 1424, 19-23.

**DISRUPTION OF MUSCLE STRESS-MEDIATED MINERAL ORIENTATION AT THE NANOSCALE IN THE SCAPULAR BONES OF RICKETS MICE WITH DEVELOPMENT.**

Karunaratne A, Davis G, Hiller J, Esapa C, Terrill N, Brown S, Cox R, Thakker R and Gupta H. *Journal of Biomechanics* vol. 45,.Elsevier.

**Strain transfer through the aortic valve.**

Anssari-Benam A, Gupta HS and Screen HRC. *Journal of Biomechanical Engineering* vol. 134, (6).

**Significant deterioration in nanomechanical quality occurs through incomplete extrafibrillar mineralization in rachitic bone: Evidence from in-situ synchrotron X-ray scattering and backscattered electron imaging.**

Karunaratne A, Esapa CR, Hiller J, Boyde A, Head R, Bassett JHD, Terrill NJ, Williams GR, Brown MA, Croucher PI, Brown SDM, Cox RD, Barber AH, Thakker RV and Gupta HS. *Journal of Bone and Mineral Research* vol. 27, (4) 876-890.

**Accelerated growth plate mineralization and foreshortened proximal limb bones in fetuin-A knockout mice.**

Seto J, Busse B, Gupta HS, Schäfer C, Krauss S, Dunlop JWC, Masic A, Kerschnitzki M, Zaslansky P, Boesecke P, Catal-Lehnens P, Schinke T, Fratzl P and Jähnen-Dechent W. *Plos One* vol. 7, (10).

## 2011

**Extrafibrillar diffusion and intrafibrillar swelling at the nanoscale are associated with stress relaxation in the soft collagenous matrix tissue of tendons.**

Screen HRC, Seto J, Krauss S, Boesecke P and Gupta HS. *Soft Matter* vol. 7, (23) 11243-11251.

**Deformation and fracture mechanisms of bone and nacre.**

Wang R and Gupta HS. *Annual Review of Materials Research* vol. 41, 41-73.

**Synchrotron 3D SAXS analysis of bone nanostructure.**

Seidel R, Gourrier A, Kerschnitzki M, Burghammer M, Fratzl P, Gupta HS and Wagermaier W. *Bioinspired, Biomimetic and Nanobiomaterials* vol. 1, 123-131.

## 2010

**Nanoscale Deformation Mechanisms in Biological Tissues.**

Gupta HS. *Nanotechnologies For The Life Sciences*. Wiley.

**Bone Nanostructure and its Relevance for Mechanical Performance, Disease and Treatment.**

Fratzl P, Gupta HS, Roschger P and Klaushofer K. *Nanotechnology* 345-360. Wiley.

**Bone material properties in lysyl oxidase knock-out mice.**

Blouin S, Paschalis E, Gupta H, Fratzl-Zelman N, Pischon N, Trackman PC, Mäki JM, Roschger P and Klaushofer K. *Bone* vol. 47,. Elsevier.

**In situ multi-level analysis of viscoelastic deformation mechanisms in tendon collagen.**

Gupta HS, Seto J, Krauss S, Boesecke P and Screen HRC. *Journal of Structural Biology* vol. 169, (2) 183-191.

## 2009

**Rational synthesis of a nanocrystalline calcium phosphate cement exhibiting rapid conversion to hydroxyapatite.**

Neira IS, Kolen'ko YV, Lebedev OI, Van Tendeloo G, Gupta HS, Matsushita N, Yoshimura M and Guitin F. *Materials Science and Engineering C* vol. 29, (7) 2124-2132.

**Collagen insulated from tensile damage by domains that unfold reversibly: In situ X-ray investigation of mechanical yield and damage repair in the mussel byssus.**

Harrington MJ, Gupta HS, Fratzl P and Waite JH. *Journal of Structural Biology* vol. 167, (1) 47-54.

**Inhomogeneous fibril stretching in antler starts after macroscopic yielding: Indication for a nanoscale toughening mechanism.**

Krauss S, Fratzl P, Seto J, Currey JD, Estevez JA, Funari SS and Gupta HS. *Bone* vol. 44, (6) 1105-1110.

**Digital image correlation shows localized deformation bands in inelastic loading of fibrolamellar bone.**

Benecke G, Kerschnitzki M, Fratzl P and Gupta HS. *Journal of Materials Research* vol. 24, (2) 421-429.

**Nanoscale deformation mechanisms in bone.**

Gupta H, Krauss S, Seto J, Wagermaier W, Kerschnitzki M, Benecke G, Zaslansky P, Boesecke P, Funari SS, Kirchner HOK and Fratzl P. *Bone* vol. 44, S33-S34.

**An Effective Morphology Control of Hydroxyapatite Crystals via Hydrothermal Synthesis.**

Neira IS, Kolen'ko YV, Lebedev OI, Van Tendeloo G, Gupta HS, Guitian F and Yoshimura M. *Cryst Growth Des* vol. 9, (1) 466-474.

## 2008

**Nanoscale deformation mechanisms in collagen.**

Gupta HS.

**Fracture of bone tissue: The 'hows' and the 'whys'.**

Gupta HS and Ziopoulos P. *Medical Engineering and Physics* vol. 30, (10) 1209-1226.

**Tough lessons from bone: Extreme mechanical anisotropy at the mesoscale.**

Seto J, Gupta HS, Zaslansky P, Wagner HD and Fratzl P. *Advanced Functional Materials* vol. 18, (13) 1905-1911.

**Nanoscale Mechanisms of Bone Deformation and Fracture.**

Fratzl P and Gupta HS.

## 2007

**Hindered crack propagation in materials with periodically varying young's modulus - Lessons from biological materials.**

Fratzl P, Gupta HS, Fischer FD and Kolednik O. *Advanced Materials* vol. 19, (18) 2657-2661.

**Raman imaging of two orthogonal planes within cortical bone.**

Kazanci M, Wagner HD, Manjubala NI, Gupta HS, Paschalis E, Roschger P and Fratzl P. *Bone* vol. 41, (3) 456-461.

**Evidence for an elementary process in bone plasticity with an activation enthalpy of 1 eV.**

Gupta HS, Fratzl P, Kerschnitzki M, Benecke G, Wagermaier W and Kirchner HOK. *Journal of The Royal Society Interface* vol. 4, (13) 277-282.

**Scanning X-ray imaging with small-angle scattering contrast.**

Gourrier A, Wagermaier W, Burghammer M, Lammie D, Gupta HS, Fratzl P, Riek C, Wess TJ and Paris O. *Journal of Applied Crystallography* vol. 40, (SUPPL. 1).

**Mechanical functionality by hierarchical structuring Lessons from biological materials.**

Fratzl P, Gupta H and Burgert I. *Comparative Biochemistry and Physiology Part a Molecular & Integrative Physiology* vol. 146, (4). Elsevier.

**Scanning texture analysis of lamellar bone using microbeam synchrotron X-ray radiation.**

Wagermaier W, Gupta HS, Gourrier A, Paris O, Roschger P, Burghammer M, Riek C and Fratzl P. *Journal of Applied Crystallography* vol. 40, (1) 115-120.

## 2006

**Cooperative deformation of mineral and collagen in bone at the nanoscale.**

Gupta HS, Seto J, Wagermaier W, Zaslansky P, Boesecke P and Fratzl P. *Proc Natl Acad Sci U S A* vol. 103, (47) 17741-17746.

**Mechanical modulation at the lamellar level in osteonal bone.**

Gupta HS, Stachewicz U, Wagermaier W, Roschger P, Wagner HD and Fratzl P. *Journal of Materials Research* vol. 21, (8) 1913-1921.

**Fibrillar level fracture in bone beyond the yield point.**

Gupta HS, Wagermaier W, Zickler GA, Hartmann J, Funari SS, Roschger P, Wagner DH and Fratzl P. *International Journal of Fracture* vol. 139, (3-4) 425-436.

**Spiral twisting of fiber orientation inside bone lamellae.**

Wagermaier W, Gupta HS, Gourrier A, Burghammer M, Roschger P and Fratzl P. *Biointerphases* vol. 1, (1) 1-5.

## 2005

**Retrosynthesis of nacre via amorphous precursor particles.**

Gehrke N, Nassif N, Pinna N, Antonietti M, Gupta HS and Clfen H. *Chemistry of Materials* vol. 17, (26) 6514-6516.

**Nanoscale deformation mechanisms in bone.**

Gupta HS, Wagermaier W, Zickler GA, Aroush DRB, Funari SS, Roschger P, Wagner HD and Fratzl P. *Nano Letters* vol. 5, (10) 2108-2111.

**Diffracting stacks of cards - Some thoughts about small-angle scattering from bone.**

Fratzl P, Gupta HS, Paris O, Valenta A, Roschger P and Klaushofer K. *Progress in Colloid and Polymer Science* vol. 130, 33-39.

**Two different correlations between nanoindentation modulus and mineral content in the bone-cartilage interface.**

Gupta HS, Schratter S, Tesch W, Roschger P, Berzlanovich A, Schoeberl T, Klaushofer K and Fratzl P. *Journal of Structural Biology* vol. 149, (2) 138-148.

## 2004

**On the role of interface polymers for the mechanics of natural polymeric composites.**

Fratzl P, Burgert I and Gupta HS. *Physical Chemistry Chemical Physics* vol. 6, (24) 5575-5579.

**Mechanical properties of spruce wood cell walls by nanoindentation.**

Gindl W, Gupta HS, Schberl T, Lichtenegger HC and Fratzl P. *Applied Physics a: Materials Science and Processing* vol. 79, (8) 2069-2073.

**Synchrotron diffraction study of deformation mechanisms in mineralized tendon.**

Gupta HS, Messmer P, Roschger P, Bernstorff S, Klaushofer K and Fratzl P. *Physical Review Letters* vol. 93, (15).

**Structure and mechanical quality of the collagen-mineral nano-composite in bone.**

Fratzl P, Gupta HS, Paschalidis EP and Roschger P. *Journal of Materials Chemistry* vol. 14, (14) 2115-2123.

**Using kinetic Monte Carlo simulations to study phase separation in alloys.**

Weinkamer R, Fratzl P, Gupta HS, Penrose O and Lebowitz JL. *Phase Transitions* vol. 77, (5-7) 433-456.

## 2003

**Measurements of mechanical properties in Ni-base superalloys using nanoindentation and atomic force microscopy.**

Schberl T, Gupta HS and Fratzl P. *Materials Science and Engineering: A* vol. 363, (1-2) 211-220.

**Mineralized microstructure of calcified avian tendons: A scanning small angle X-ray scattering study.**

Gupta HS, Roschger P, Zizak I, Fratzl-Zelman N, Nader A, Klaushofer K and Fratzl P. *Calcified Tissue International* vol. 72, (5) 567-576.

**Constant mineralization density distribution in cancellous human bone.**

Roschger P, Gupta HS, Berzlanovich A, Ittner G, Dempster DW, Fratzl P, Cosman F, Parisien M, Lindsay R, Nieves JW and Klaushofer K. *Bone* vol. 32, (3) 316-323.

**Effect of interphase boundaries on nanoindentation experiments on a Ni-base alloy.**

Schberl T and Gupta HS. *Zeitschrift Fuer Metallkunde/Materials Research and Advanced Techniques* vol. 94, (7) 813-818.

## 2002

**Lignification of spruce tracheid secondary cell walls related to longitudinal hardness and modulus of elasticity using nano-indentation.**

Gindl W, Gupta HS and Grunwald C. *Can J Bot* vol. 80, (10) 1029-1033.

**Cell-wall hardness and Young's modulus of melamine-modified spruce wood by nano-indentation.**

Gindl W and Gupta HS. *Composites Part a: Applied Science and Manufacturing* vol. 33, (8) 1141-1145.

## 2001

**Microscopic computer simulations of directional coarsening in face-centered cubic alloys.**

Gupta H, Weinkamer R, Fratzl P and Lebowitz JL. *Acta Materialia* vol. 49, (1) 53-63. Elsevier.

**Precipitate size distribution in alloys with and without lattice misfit.**

Weinkamer R, Gupta H, Lebowitz JL and Fratzl P. *Zeitschrift Fuer Metallkunde/Materials Research and Advanced Techniques* vol. 92, (1) 9-13.

## 2000

**Dynamics of mesoscopic precipitate lattices in phase-separating alloys under external load.**

Weinkamer R, Gupta H, Fratzl P and Lebowitz JL. *Europhysics Letters* vol. 52, (2) 224-230.

## 1996

**Backbones of traffic jams.**

Gupta HS and Ramaswamy R. *Journal of Physics a: Mathematical and Theoretical* vol. 29, (21). Iop Publishing.