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Engineering & Scientific Consulting

Baptiste Depalle, Ph.D.
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Professional Profile

Dr. Depalle specializes in solid mechanics, structural and mechanical characterization of complex composite materials, tissue biomechanics, custom design of testing instrumentation, and precision sample preparation. He has more than 10 years of experience in bridging numerical simulations and experimental data to characterize mechanical properties of materials. Dr. Depalle has expertise in a range of materials characterization techniques including confocal and electron microscopy (TEM, SEM, FIB), microtomography, mechanical testing (Indentation, AFM). He is an expert in biological sample preparation methods for microscopy and mechanical testing and can provide guidance to minimize sample preparation damage and experimental artifacts. He has expertise in algorithm design for image acquisition, image processing and data analysis including image segmentation, feature detection and image registration. Dr. Depalle also has a demonstrated expertise in the design and development of customized computer-controlled instrumentation for microscale sample testing and data collection.

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Prior to joining Exponent, Dr. Depalle was a Principal Investigator at the Forsyth Institute, one of the leading centers for dental and craniofacial research. His research focused on the molecular origins of mechanical properties of the dentin-enamel junction and the role of proteins on the toughness of dental enamel. His work aimed at providing a better understanding of the mechanisms behind the remarkable mechanical properties of tooth enamel to design novel bioinspired materials optimized for strength and toughness. His work led to identifying novel post-eruptive mineralization process in porcine enamel and new micro-level of organization in the hierarchical structure of mouse enamel. Dr. Depalle also designed and built several instruments including a computer-controlled sampling device to collect mineralized tissues samples with sub-micron accuracy using machine control and computer vision and a 3D imaging platform for biological samples.

Dr. Depalle earned his Doctorate in Biomechanics form the National Institute of Applied Sciences of Lyon, France, in 2011 studying the impact of tissue heterogeneity on trabecular bone fragility. His work focused on the assessment of the mechanical properties of human trabecular bone to improve the diagnostic of bone fragility diseases such as osteoporosis. He completed postdoctoral training at both Massachusetts Institute of Technology and Imperial College London on bone nanostructure and modifications induced by bone diseases. His research combined molecular modelling methods with high-resolution electron microscopy and diffraction techniques to identify the nanoscale mechanisms responsible for altering higher-scale mechanical properties in bone. He has developed customized molecular models of bone tissue and new sample preparation protocols for electron-microscopy to minimize electron beam damage and improve contrast in biological samples.

Academic Credentials & Professional Honors

Ph.D., Biomechanics, Institut National des Sciences Appliquees, 2011

M.S., Mechanical Engineering, National Institute of Applied Sci of Lyon, 2007

New Investigator Award, 10th International Symposium on Dental Enamel, 2022

Wellcome Trust/MIT fellowship 2012-2017

Outstanding Paper Award, American Society of Mechanical Engineers (ASME), 2013

Young Investigator Award, French Society of Mineralized Tissue Biology (SFBTM), 2009 and 2010

Prior Experience

Principal Investigator, The Forsyth Institute (Cambridge, MA), 2019-2022

Postdoctoral Associate, The Forsyth Institute (Cambridge, MA), 2018-2019

Postdoctoral Research Fellow, Imperial College London (London, United-Kingdom), 2015-2017

Postdoctoral Research Fellow, Massachusetts Institute of Technology (Cambridge, MA), 2012-2015

Professional Affiliations

New England Society for Microscopy (2018-present)

Languages

French (France)

Publications

[2023] B. Depalle, H. Karaaslan, N. Obtel, A. Gil-Bona, M. Teichmann, G. Mascarin, M. Pugach-Gordon, and F.B. Bidlack. Rapid Post-Eruptive Maturation of Porcine Enamel. Front. Physiol. 14, doi: 10.3389/fphys.2023.1099645

[2021] B. Depalle, C.M. McGilvery, S. Nobakhti, N. Aldegaither, S.J. Shefelbine, and A.E. Porter. Osteopontin regulates type I collagen fibril formation in bone tissue. Acta Biomater. 120, 194–202. doi: 10.1016/j.actbio.2020.04.040.

[2019] I.A.K. Fiedler, S. Zeveleva, A. Duarte, X. Zhao, B. Depalle, L. Cardoso, S. Jin, J.P. Berteau. “Microstructure, Mineral and Mechanical Properties of Teleost Intermuscular Bones”, J Biomech. 94, 59–66.

[2018] B. Depalle, A.G. Duarte, I.A.K. Fiedler, L. Pujo-Menjouet, M.J. Buehler, J-P. Berteau. “The different distribution of enzymatic collagen cross-links found in adult and children bone result in different mechanical behavior of collagen”. Bone. 110 (2018) 107–114.

[2017] J.L. Zitnay, Y. Li, Z. Qin, B.H. San, B. Depalle, S.P. Reese, M.J. Buehler et al. ” Molecular Level Detection and Localization of Mechanical Damage in Collagen Enabled by Collagen Hybridizing Peptides”. Nature Communication, 8, 14913.

[2017] A.C. Deymier, A.K. Nair, B. Depalle B, Z. Qin, K. Arcot, C. Drouet, et al. ”Protein-free formation of

bone-like apatite : New insights into the key role of carbonation Protein-free formation of bone-like apatite : New insights into the key role of carbonation". Biomaterials, 127, 75–88.

[2016] B. Depalle, Z. Qin, S.J. Shefelbine, M.J. Buehler. "Large Deformation Mechanisms, Plasticity and Failure of an Individual Collagen Fibril with Different Mineral Content". Journal of Bone and Mineral Research, 31, 380–390.

[2015] B. Depalle, Z. Qin, S.J. Shefelbine, M.J. Buehler. "Influence of cross-link structure, density and mechanical properties in the mesoscale deformation mechanisms of collagen fibrils". Journal of the Mechanical Behavior of Biomedical Materials, 1–13. doi:10.1016/j.jmbbm.2014.07.008

[2013] B. Depalle, R. Chapurlat, H. Walter-Le-Berre, B. Bou-Said, H. Follet. "Finite Element Dependence of Stress Evaluation for Human Trabecular Bone". Journal of the Mechanical Behavior of Biomedical Materials, 18:200-12.

[2013] A. Fradet, H. Sorel, B. Depalle, C.M. Serre, D. Farlay, A. Turtoi, E. Bonnelye. "A new murine model of osteoblastic/osteolytic lesions from human androgen-resistant prostate cancer". PloS One, 8(9), e75092. doi:10.1371/journal.pone.0075092

[2011] B. Depalle, Y.Bala, T. Douillard, S. Meille, P. Clément, H. Follet, J. Chevalier, G. Boivin. "Respective roles of organic and mineral components of bone matrix in micromechanical behavior: an instrumented indentation study". Journal of the Mechanical Behavior of Biomedical Materials, 2011, 4(7):1473-82.

[2011] A. Fradet, H. Sorel, L. Bouazza, D. Goehrig, B. Depalle, A. Bellahcène, V. Castronovo, H. Follet, J.E. Aubin, P. Clézardin & E. Bonnelye. "Dual function of ERRalpha in breast cancer and bone metastasis formation: implication of VEGF and osteoprotegerin". Cancer Research, 2011, 71(17):5728-38.

[2011] Y.Bala, B. Depalle, T. Douillard, S. Meille, R.D. Chapurlat, J. Chevalier, G. Boivin. "Alendronate long-term treatment in postmenopausal osteoporotic women is associated with alterations in crystallinity and micromechanical properties of bone at structural unit level". Journal of Bone and Mineral Research, 2011, 27(4):825-34.

[2011] H.C. Follet, S. Viguet-Carrin, B. Burt-Pichat, B. Depalle, Y. Bala, E. Gynest, M. Arlot, G. Boivin, R.D. Chapurlat, P.D. Delmas, M.L. Bouxsein. "Effects of pre-existing microdamage, collagen cross-links, secondary mineralization, age, bone volume fraction and architecture on compressive mechanical properties of elderly human vertebral trabecular bone". Journal of Orthopaedic Research 2011, 29(4):481-8.

Seminar Presentations

[2022] B. Depalle, M. Yasodharababu, S. Kraemer, A.K. Nair, F.B. Bidlack. "Impact of the Interface Between Rod and Interrod on the Macro-Scale Mechanics of Enamel". 10th International Symposium of Dental Enamel, Pittsburgh, PA, May 8-12.

[2022] B. Depalle, M. Teichmann, A. Gil-Bona, N. Obtel, G. Mascarin, M. Pugach-Gordon, and F.B. Bidlack. "Rapid Post-Eruptive Maturation of Porcine Enamel". 10th International Symposium of Dental Enamel, Pittsburgh, PA, May 8-12.

[2016] B. Depalle, Z. Qin, S.J. Shefelbine, M.J. Buehler. "Influence of Cross-links Distribution on the Tensile Properties of a Single Collagen Fibril". 22nd Congress of the European Society of Biomechanics. Lyon, France, July 10-13.

[2016] B. Depalle, A.G. Duarte, I.A.K. Fiedler, M.J. Buehler, L. Pujot-Menjouet, J.P. Berteau. "Enzymatic Cross-links are a Major Determinant of Children Cortical Bone Post-Yield Mechanical Behavior". 22nd Congress of the European Society of Biomechanics. Lyon, France, July 10-13.

[2015] B. Depalle, Z. Qin, M.J. Buehler. ”Development of a Coarse-Grained Model to Explore the Influence of Extrafibrillar Mineral on Bone Tissue Mechanics”. International Conference on Computational and Mathematical Biomedical Engineering, Cachan: 2015.

[2014] B. Depalle, Z. Qin, S.J. Shefelbine, M.J. Buehler. ”Mesoscale modeling of collagen fibrils: influence of cross-links and mineralization on the fibril mechanics”. World Congres of Biomechanics. Boston, MA, USA, July 6-11.

[2011] B. Depalle, B. Bou-Saïd, R.C. Chapurlat, H. Follet. ”Stress evaluation in trabecular bone by finite element modeling”. 13th Meeting of the French Society of Mineralized Tissue Biology, Paris, France. June 24-27.

[2010] B. Depalle, Y. Bala, T. Douillard, S. Meille, H. Follet, J.Chevalier, G. Boivin. ”Contribution of bone microstructural characteristics to mechanical properties evaluated at bone structural unit level”. 12th Meeting of the French Society of Mineralized Tissue Biology, Saint-Etienne, France. June 9-11.

[2009] L.Cueru, A-M. Trunfio-Sfarghiu, Y. Bala, B. Depalle, A. Descamps, G. Boivin, Y. Berthier, H. Follet. “Correlation between microstructure and nanomechanical properties of lamellar bone”. 3rd International Conference on Mechanics of Biomaterials & Tissues. Clearwater Beach, Florida, USA December 13-17.

[2009] L.Cueru, A-M. Trunfio-Sfarghiu, Y. Bala, B. Depalle, A. Descamps, G. Boivin, Y. Berthier, H. Follet. “Correlation between microstructure and nanomechanical properties of lamellar bone”. The International Symposium on Assistive and Recuperative Technologies for Injured, ill, Pregnant, Elderly and people with Disabilities. Faculty of Medical Bioengineering, Iasi, Romania July 23-25.

[2008] B. Dépalle, R.C. Chapurlat, B. Bou-Saïd, H. Follet. ”Mechanical properties of vertebral trabecular bone in human”. Abaqus User Meeting. Paris, France, November 20.