

## Hen Eggshell Based Composite as Prospective Dental Material

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**Abstract.** Deformation behavior under uniaxial compression and diametral compression of samples compacted from hen eggshell powder with different binders was examined. Depending on concentration and mechanical properties of a binder, deformation behavior of compacted powder can be changed from that inherent to biominerals, for example, tooth enamel and some magmatic rocks, to behavior that close to the viscous behavior of human dentin and some filled polymers or rubber. Hence, mechanical properties of this composite are qualitatively closed to the hard tissues of human tooth. Analysis of dangerous cracks morphology in composites from hen eggshell has confirmed that some features of the viscous deformation behavior are really take place in these materials under compression and tension. This allows considering hen eggshell based composites as prospective materials intended for tooth implants.

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## REFERENCES

- [1] [M.A. Meyers](#), *Structural Biological Materials: Critical Mechanics-Materials Connections*, *Science*, 2013, vol. 339, no. 6121, pp. 773–779.
- [2] H.O. Heymann, E.J. Swift, A.V. Ritter (Eds.), *Sturdivant's Art and Science of Operative Dentistry*, Elsevier, Amsterdam, 2013.
- [3] D.V. Zaytsev, S.S. Grigoriev, P.Ye. Panfilov, *The nature of strength of dentin and enamel of human tooth*, Siberian Branch of Russian Academy of Sciences, Novosibirsk, 2017 (in Russian).

- [4] L.H. He, M.V. Swain, Understanding the mechanical behavior of human enamel from its structural and compositional characteristics, *Journal of the Mechanical Behavior of Biomedical Materials*, 2008, vol. 1, no. 1, pp. 18–29.
- [5] N.B. Cramer, J.W. Stansbury, C.N. Bowman, Recent advances and developments in composite dental restorative materials, *Journal of Dental Research*, 2011, vol. 90, no. 4, pp. 402–416.
- [6] J.H. Kinney, S.J. Marshall, G.W. Marshall, The mechanical properties of human dentin: a critical review and re-evaluation of the dental literature, *Critical Reviews in Oral Biology & Medicine*, 2003, vol. 14, no. 1, pp. 13–29.
- [7] L.E. Bertassoni, Dentin on the nanoscale: Hierarchical organization, mechanical behavior and bioinspired engineering, *Dental Materials*, 2017, vol. 33, no. 6, pp. 637–649.
- [8] P. Panfilov, A. Kabanova, J. Guo, Z. Zhang, Transmission electron microscopical study of teenage crown dentin on the nanometer scale, *Materials Science & Engineering C*, 2017, vol. 71, pp. 994–998.
- [9] A. Besinis, T. De Peralta, C.J. Tredwin, R.D. Handy, A review of nanomaterials in dentistry: Interactions with the oral microenvironment, clinical applications, hazards and benefits, *ACS Nano*, 2015, vol. 24, no. 3, pp. 2255–2289.
- [10] S. Deb, S. Chana, Biomaterials in Relation to Dentistry, in: P.T. Sharpe (Ed.), *Frontiers of Oral Biology, Vol. 17*, Karger, Basel, 2015, pp. 1–12.
- [11] S.E. Solomon, The eggshell: strength, structure and function, *British Poultry Science*, 2010, vol. 51, pp. 52–59.
- [12] P. Panfilov, D. Zaytsev, M. Mezhenov, S. Grigoriev, Bending Deformation Behavior of Eggshell and Eggshell–Polymer Composites, *Journal of Composites Science*, 2023, vol. 7, no. 8, art. no. 336.
- [13] M. Mezhenov, D. Zheludkov, A. Kabanova, D. Zaytsev, P. Panfilov, Deformation Behavior of Chicken Eggshell, *AIP Conference Proceedings*, 2022, vol. 2509, art. no. 020131.
- [14] J.A. Hudson, J.P. Harrison, *Engineering Rock Mechanics. An Introduction to the Principles*, Pergamon, Amsterdam, 2000.
- [15] J.F. Knott, *Fundamentals of Fracture Mechanics*, Butterworths, London, 1973.
- [16] M. Kachanov, I. Sevostianov, *Micromechanics of Materials, with Applications*, Book series: Solid Mechanics and Its Applications, vol. 249, Springer Nature, Berlin, 2018.
- [17] R.F. Cook, G.M. Pharr, Direct observation and analysis of indentation cracking in glasses and ceramics, *Journal of the American Ceramic Society*, 1990, vol. 73, no. 4, pp. 787–817.
- [18] A.S. Argon, *The physics of deformation and fracture of polymers*, Cambridge University Press, Cambridge, 2013.
- [19] R.H. Vernon, *A practical guide to Rock Microstructure*, Cambridge University Press, Cambridge, 2004.
- [20] A.S. Argon, *Strengthening Mechanisms in Crystal Plasticity*, Oxford University Press, Oxford, 2007.
- [21] R.L. Lyles Jr., H.G.F. Wilsdorf, Microcrack nucleation and fracture in silver crystals, *Acta Metallurgica*, 1975, vol. 23, no. 2, pp. 269–277.
- [22] P. Panfilov, M. Mezhenov, J. Guo, D. Zaitsev, On Some Feature of Deformation Behavior of a Bird Eggshell, *Reviews on Advanced Materials and Technologies*, 2024, vol. 6, no. 3, pp. 96–112.
- [23] P. Panfilov, M. Mezhenov, A. Kuklina, J. Guo, D. Zaytsev, On cleavage crack morphology in some rock materials of different genesis, *Materials Letters*, 2025, vol. 379, art. no. 137702.