The ability of a nanobioglass-doped self-etching adhesive to re-mineralize and bond to artificially demineralized dentin

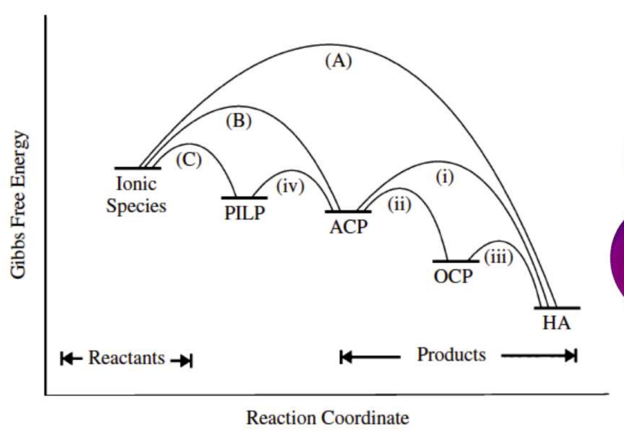
Abuna, Gabriel[1-3]. Campos, Ferreira Paulo[1]. Hirashi, Noriko[2]. Giannini, Marcelo[1]. Nikaido, Toru[2]. Tagami, Junji[2]. Geraldeli, Saulo [3]. Sinhoreti, Coelho Mario Alexandre[1]

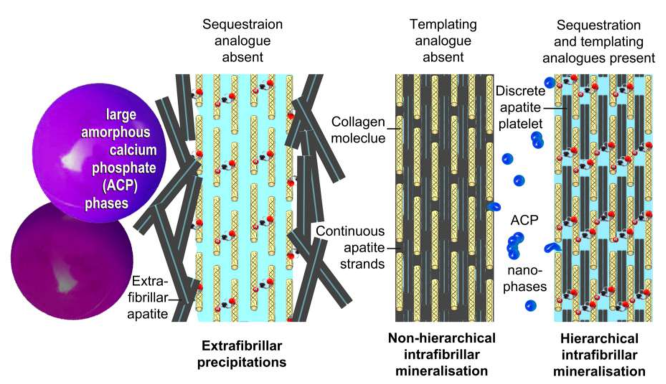
1. Restorative Dentistry Department, Dental Materials Division, Piracicaba Dental School, State University of Campinas, Piracicaba, Sao Paulo, Brazil.

2. Cariology and Operative Dentistry Department, Tokyo Medical and Dental University, Tokyo, Japan.

3. General Dentistry Department, Division of Biomedical Materials, East Carolina University School of Dental Medicine, Greenville, USA.

Background



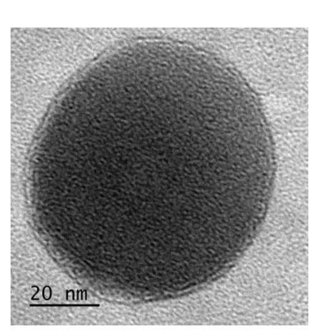


Pathway A: traditional nucleation
Pathway B: via amorphous precursor
Pathway C: additives stabilises ACP
Königsberer E. et al. 2006

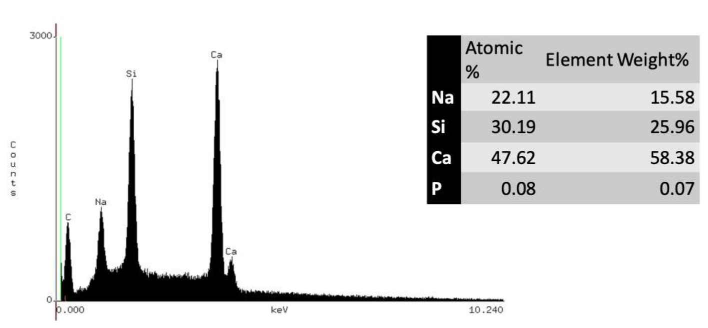
Non-hierarchical: Direct nucleation (PhosphoProtein C-terminal)
Hierarchical: single crystals without planes
Liu Y. et al. 2011.

Nanoparticle

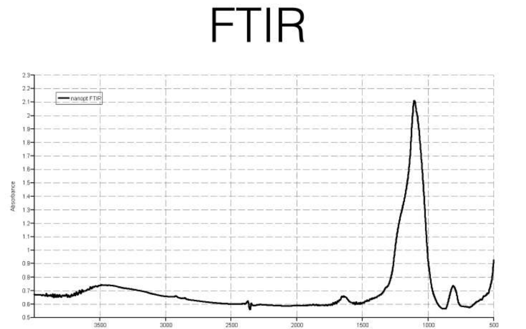
TEM



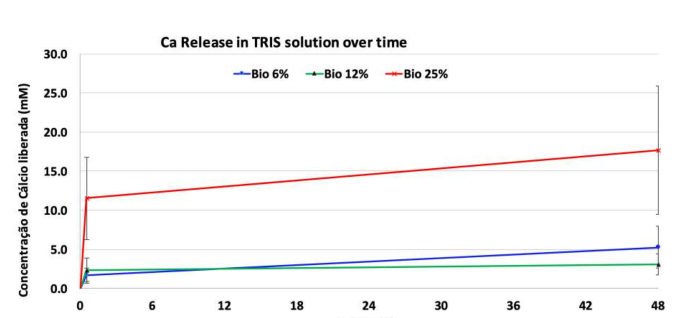
EDS



FTIR

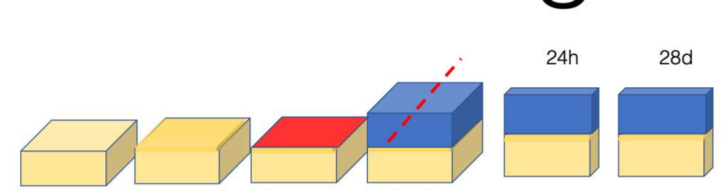


ICP

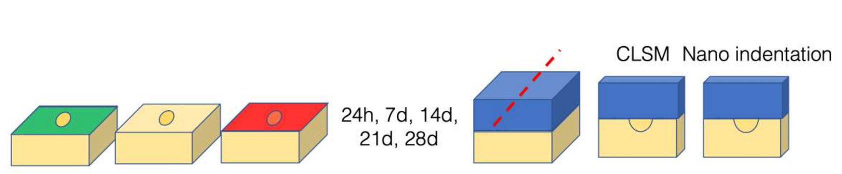


Experimental Design

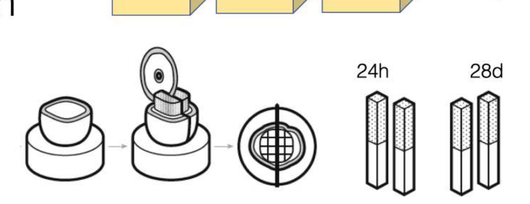
Nano Indentation
(Confocal Depth profile Keyence)



Confocal Depth profile, nano indentation

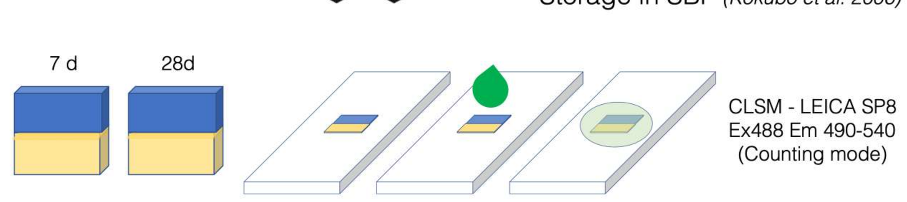


µTBS

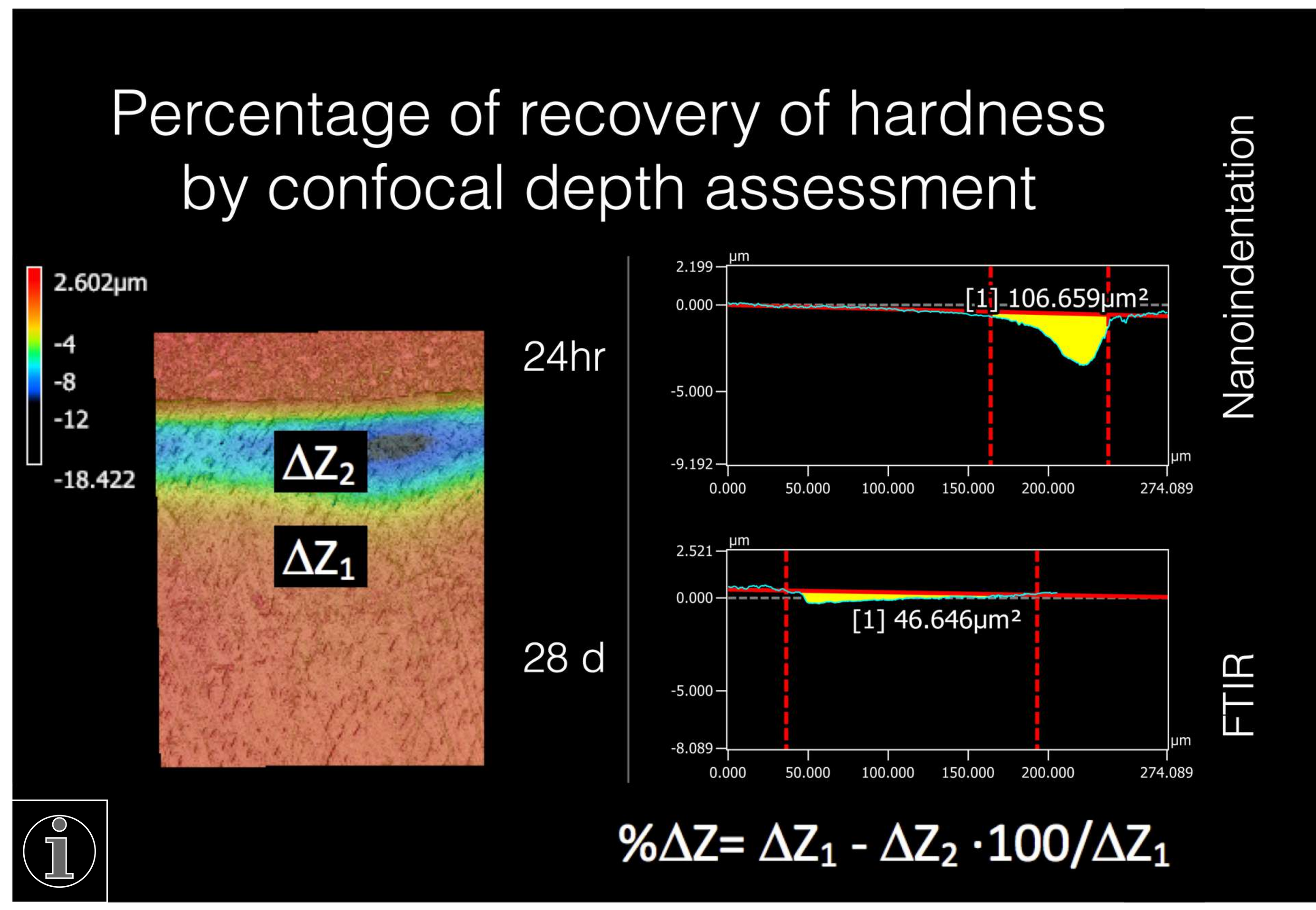


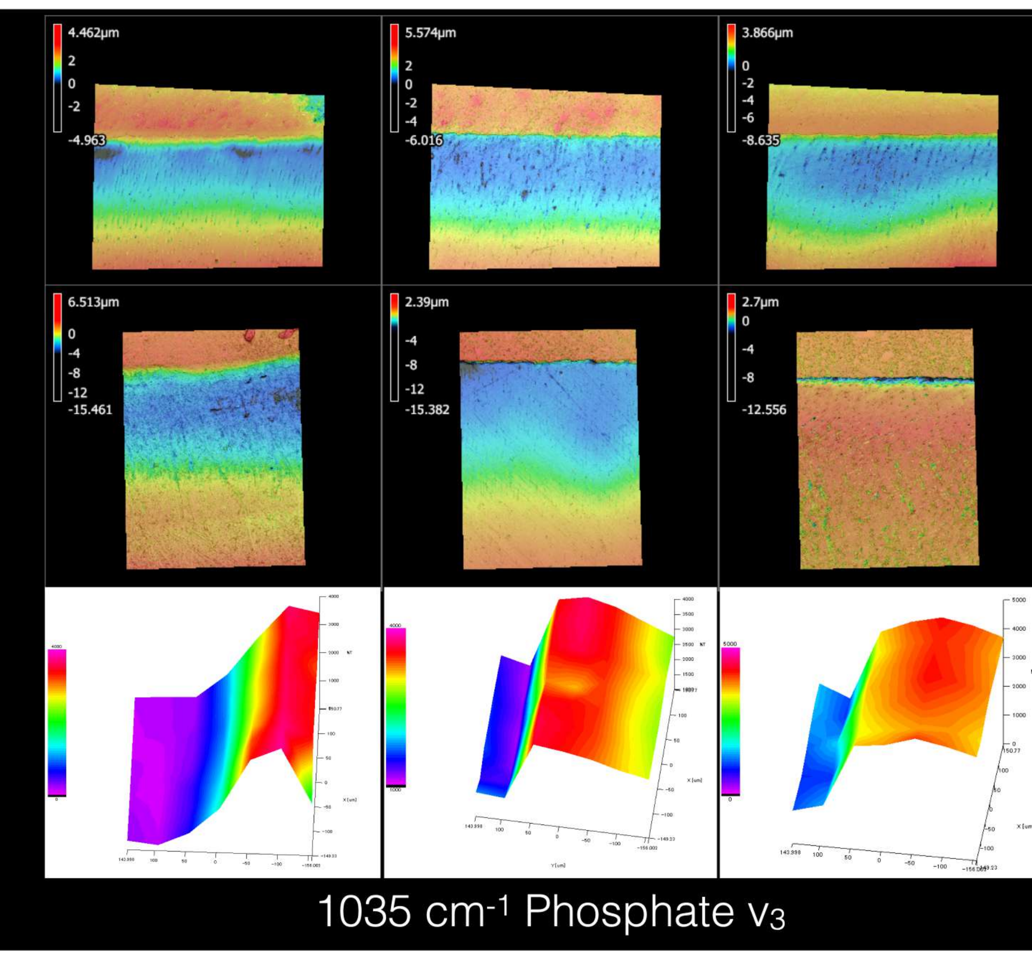
Samples were restored:
- 10 sec active application
- 20 sec evaporation solvent
- 14J/cm² (QTH unit)
- Storage in SBF *(Kokubo et al. 2006)*

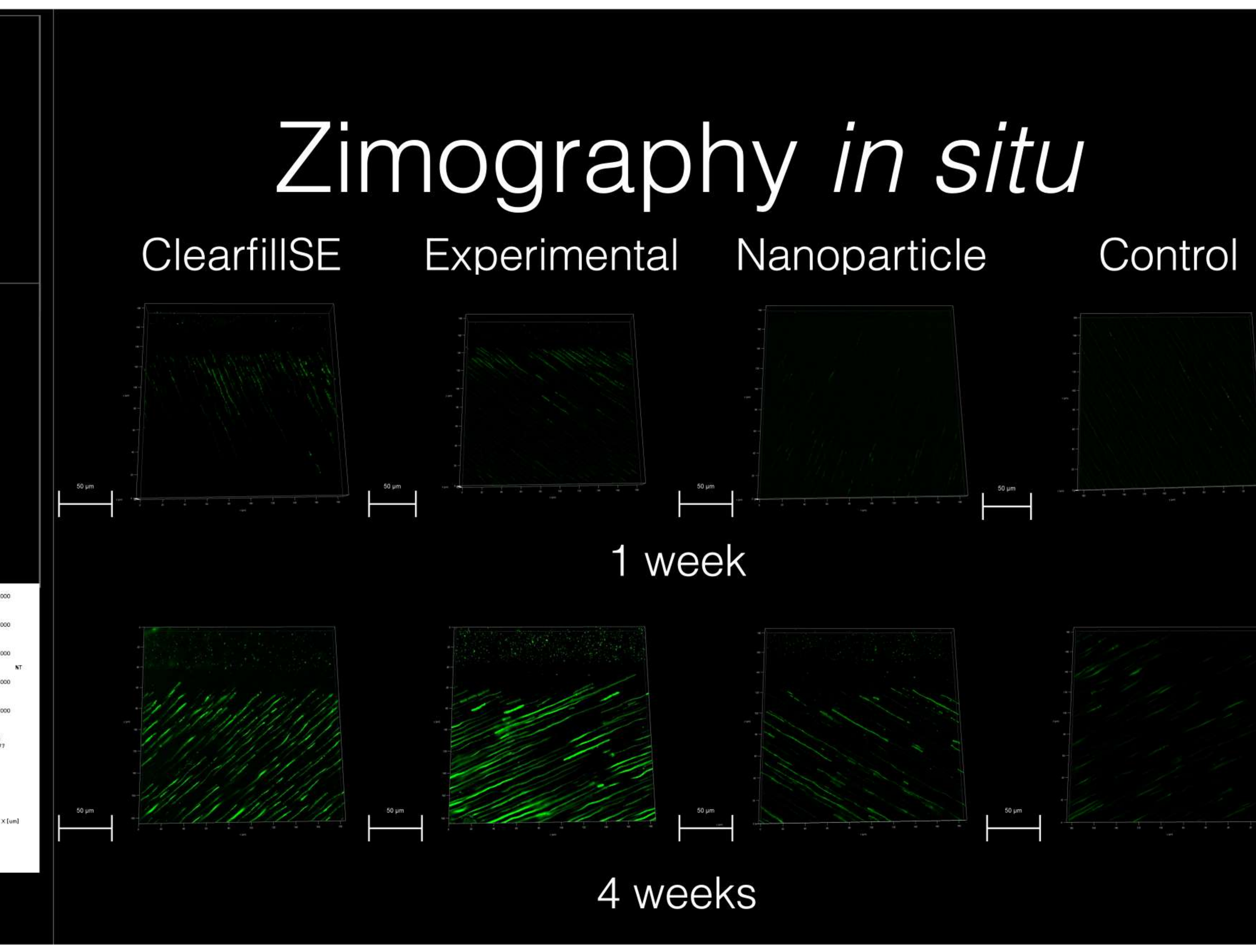
Zimography *in situ*

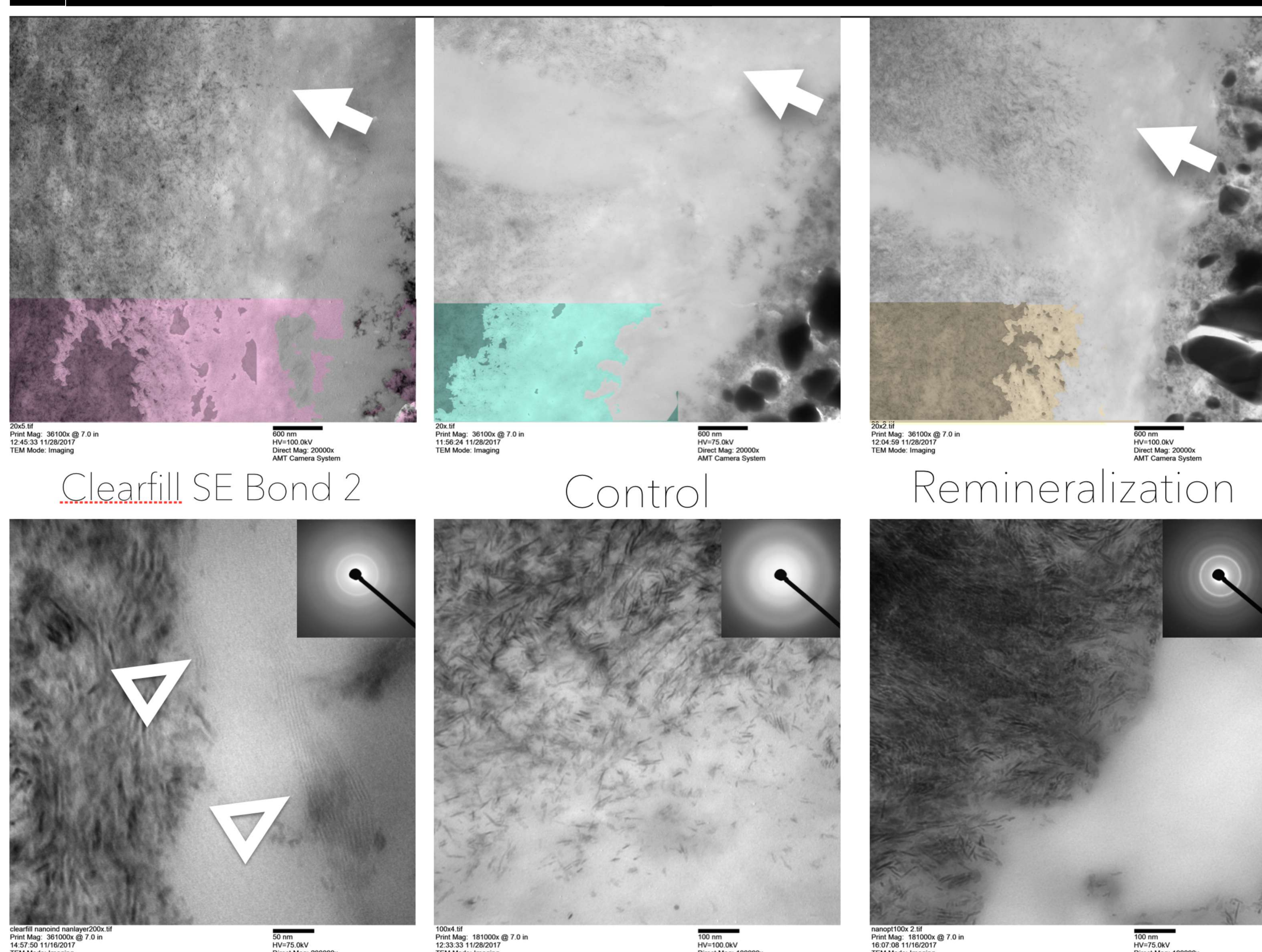


Research Question: Can we create a nanoparticle able to remineralize Caries affected Dentin, and improve the longevity of the dental restorations through time?



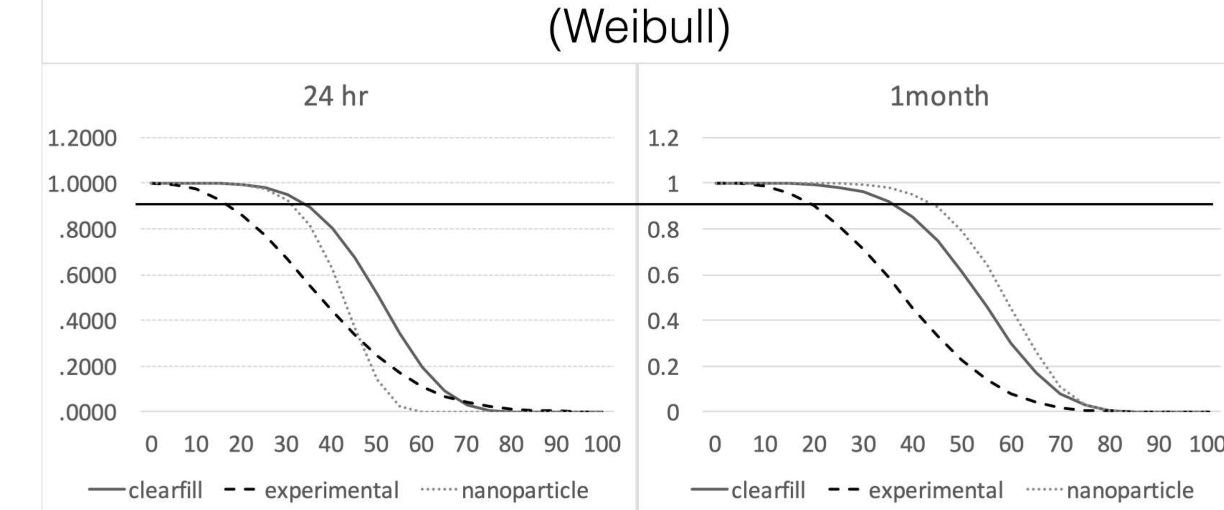






µTensile Bond Strength

(Weibull)

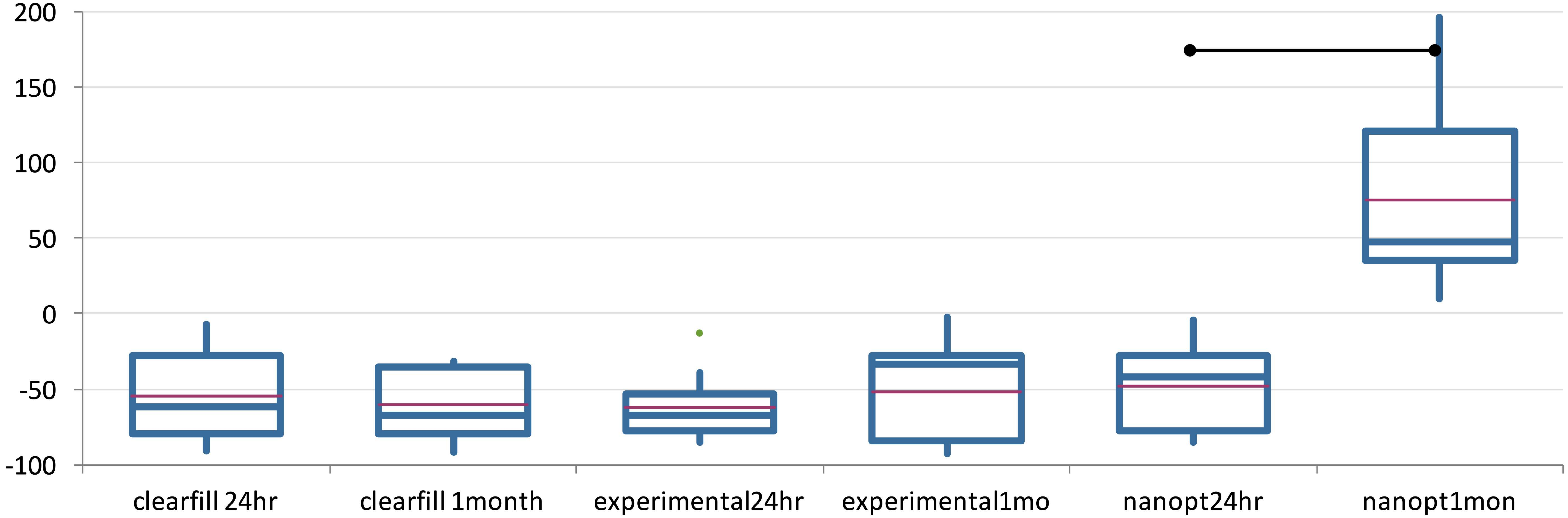


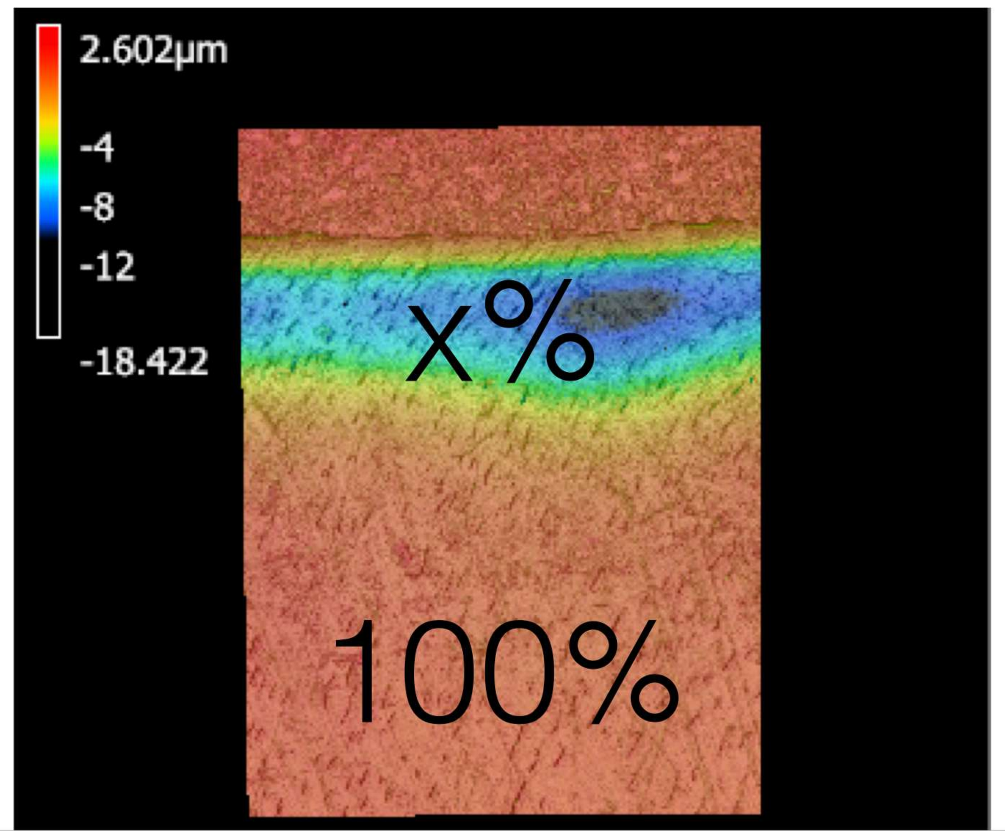
Reliability	Clearfill		Experimental		Nanoparticle	
	24hr	1month	24hr	1month	24hr	1month
1%	74.0	78.8	81.3	73.8	57.0	78.1
50%	50.4	53.7	37.4	38.3	42.4	58.9
90%	34.5	36.6	17.3	19.9	31.6	44.5
99%	21.4	22.8	6.6	8.8	21.9	31.3

Conclusions:

- The Stöbber process for creating the nanoparticle is extremely efficient.
- The Dental material was not only able to stop degradation but also to improve the mechanical properties trough time.
- The Caries affection was arrested and intrafibrillar mineralization achieved.

Nano indentation (%)

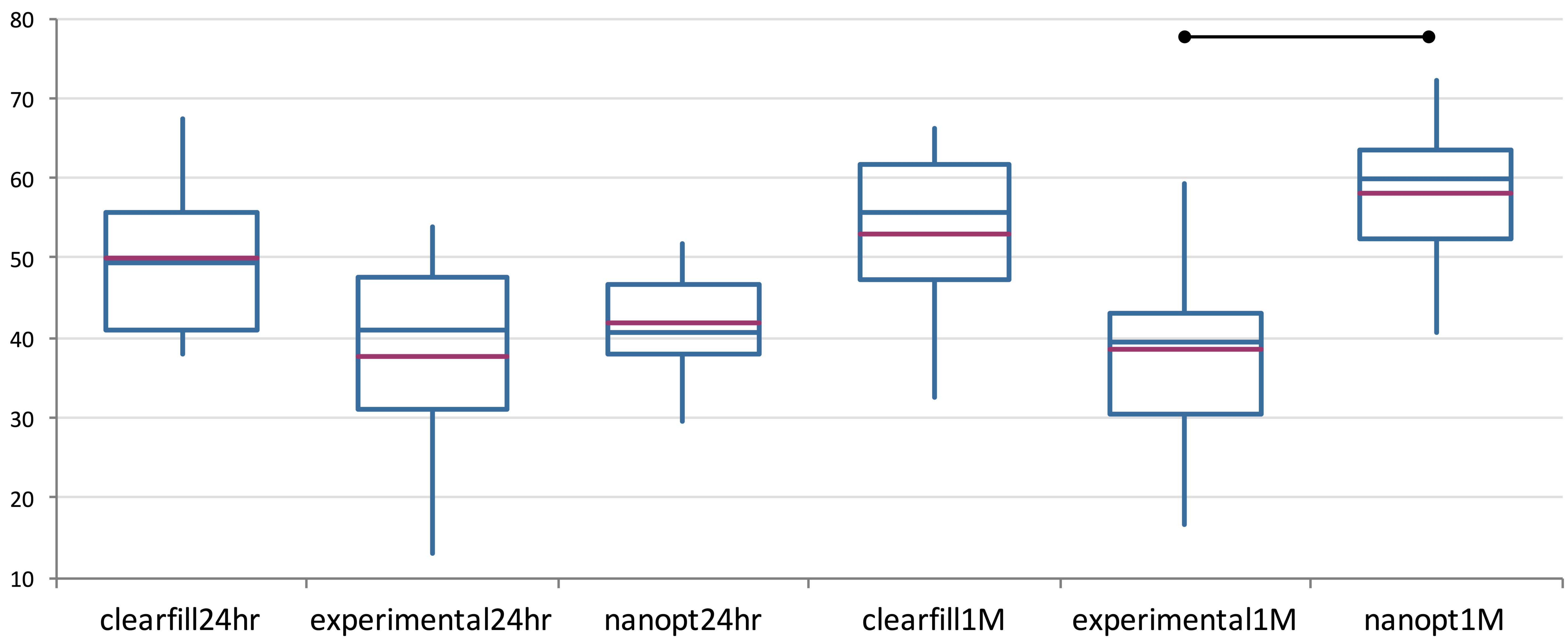




ANOVA Two way Fisher LSD, $p<0.05$

We assess the recover of mechanical property of the tissue affected, it surely recover the hardness, improving also the Elastic modulus and the stiffness. Properties directly related with the longevity of the restoration and the health of the tissue.

µTensile Bond Strength



ANOVA Two way

Fisher LSD, $p<0.05$

The Weibull m, provide a perception of how the material will behave in hypothetical time through mathematical calculus. It was calculated from the µTBS that measure the bonding strength of the material bonded to the tissue.

References

1. Boskey AL, Roy R. Cell culture systems for studies of bone and tooth mineralization. Chemical Reviews. 2008;108(11):4716–33.
2. Cölfen H. Biomineralization: A crystal-clear view. Nature materials [Internet]. Nature Publishing Group; 2010 Dec [cited 2013 Dec 16];9(12):960–1. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21102512
3. Nudelman F, Pieterse K, George A, Bomans PHH, Friedrich H, Brylka LJ, et al. The role of collagen in bone apatite formation in the presence of hydroxyapatite nucleation inhibitors. Nature Publishing Group; 2010;9(October):9–14. Available from: http://dx.doi.org/10.1038/nmat2875
4. Abuna G, Feitosa VP, Correr AB, Cama G, Giannini M, Sinhoreti MA, et al. Bonding performance of experimental bioactive/biomimetic self-etch adhesives doped with calcium-phosphate fillers and biomimetic analogs of phosphoproteins. Journal of Dentistry [Internet]. Elsevier Ltd; 2016;52:79–86. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0300571216301439
5. Amos FF, Olszta MJ, Khan SR, Gower LB. Relevance of a Polymer-Induced Liquid-Precursor (PILP) Mineralization Process to Normal and Pathological Biomineralization. Biomineralization - Medical Aspects of Solubility. 2007. 125-217 p.
6. Märten A, Fratzl P, Paris O, Zaslansky P. On the mineral in collagen of human crown dentine. Biomaterials. 2010;31(20):5479–90.
7. Kokubo T, Takadama H. How useful is SBF in predicting in vivo bone bioactivity? Biomaterials. 2006;27(15):2907–15.
8. Tsuda H. Raman spectra of human dentin mineral. European Journal of Oral Sciences. 1996;73(2):1703–131.