



Biofilm Formation and Contact Angles On Dental Restorative Biomaterials



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Objective: This aim of this study was to presented a novel Chemostat model consisting of biomaterials substrates and multiple bacterial species and used for investigating the biofilm formation. A simple method of measuring contact angles to correlate the biofilm data is also presented.

Methods: *Specimen preparation* Eight proprietary available biomaterials were selected including gold casing alloy, dental amalgam, zirconia, based-metal alloy, resin composite, glazed and ground porcelain, glass ionomer material, and lithium disilicate glass-ceramic materials. Human dentin from extracted molars and Teflon material were used as positive and negative controls, respectively, making a total of 11 test groups.

Chemostat set-up We chose to cultivate our oral mixed culture in continuous culture at a known growth rate and physiological state. A custom-built parallel flow chamber was used to investigate the bacterial attachment and biofilm formation onto the various substrates. The mixed oral consortium will be grown continuously in a Chemostat which forms one portion of a biofilm accumulation study flow system which is a continuously added, constant reaction volume, and well-mixed bioreactor (Fig. 2).

Microbial mixed culture and evaluation A microbial mixed culture comprised of 5 oral species *S. mutans* ATCC #700610, *S. gordonii* ATCC #49818, *A. naeslundii* ATCC #51655, *P. gingivalis* ATCC #33277, and *F. nucleatum* ATCC #25586 were grown continuously in the chemostat. The bacteria were analyzed fluorescently.

Wettability and Contact Angle (CA) measurement We employed the sessile drop technique by depositing uniform volume of distilled water on the surface of a solid coupled with the standard arrangement for optical measurement of the contact angle using drop shape analysis. The static contact angle was recorded with photographic image within 5 sec. The images are analyzed by computer software.

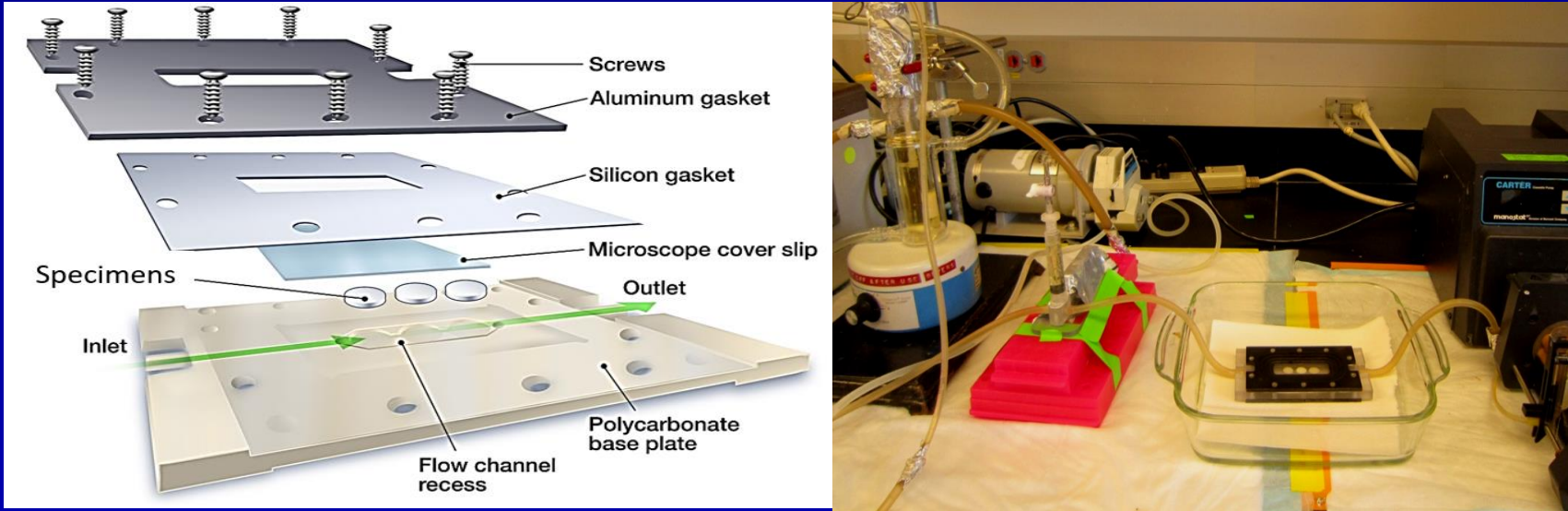


Figure 1 (A). Chemostat set-up. (B). Sterilized biomaterials disks are placed flush with the interior surface of the flow channel of a Chemostat. SEM and TEM micrographs of Au titanate nanoparticles

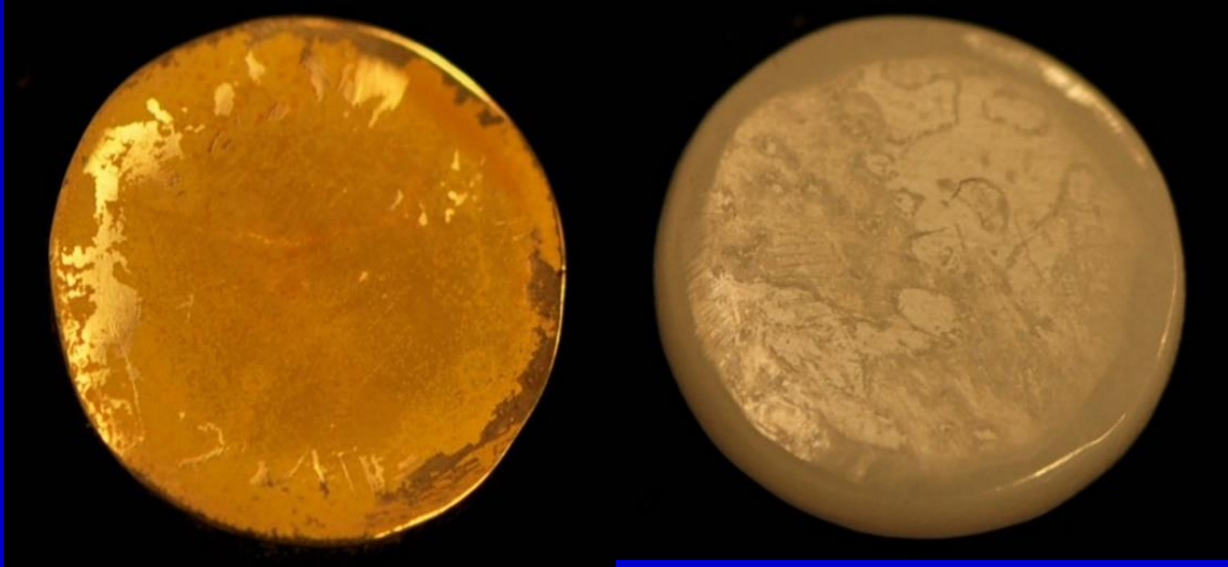


Figure 3. (A) Biofilm formation (matted appearance) on polished gold surface. (B). Similar formation on glazed porcelain surface.

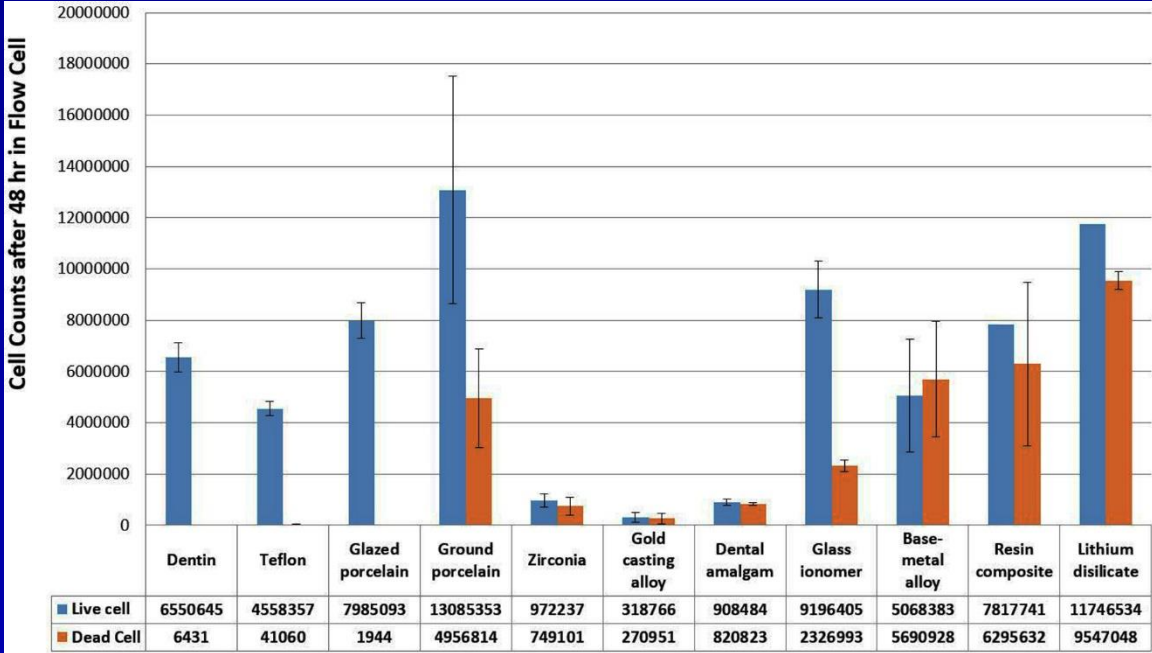


Figure 2. Live/dead cells counts on different biomaterials after 48 hours in Flow Cell.

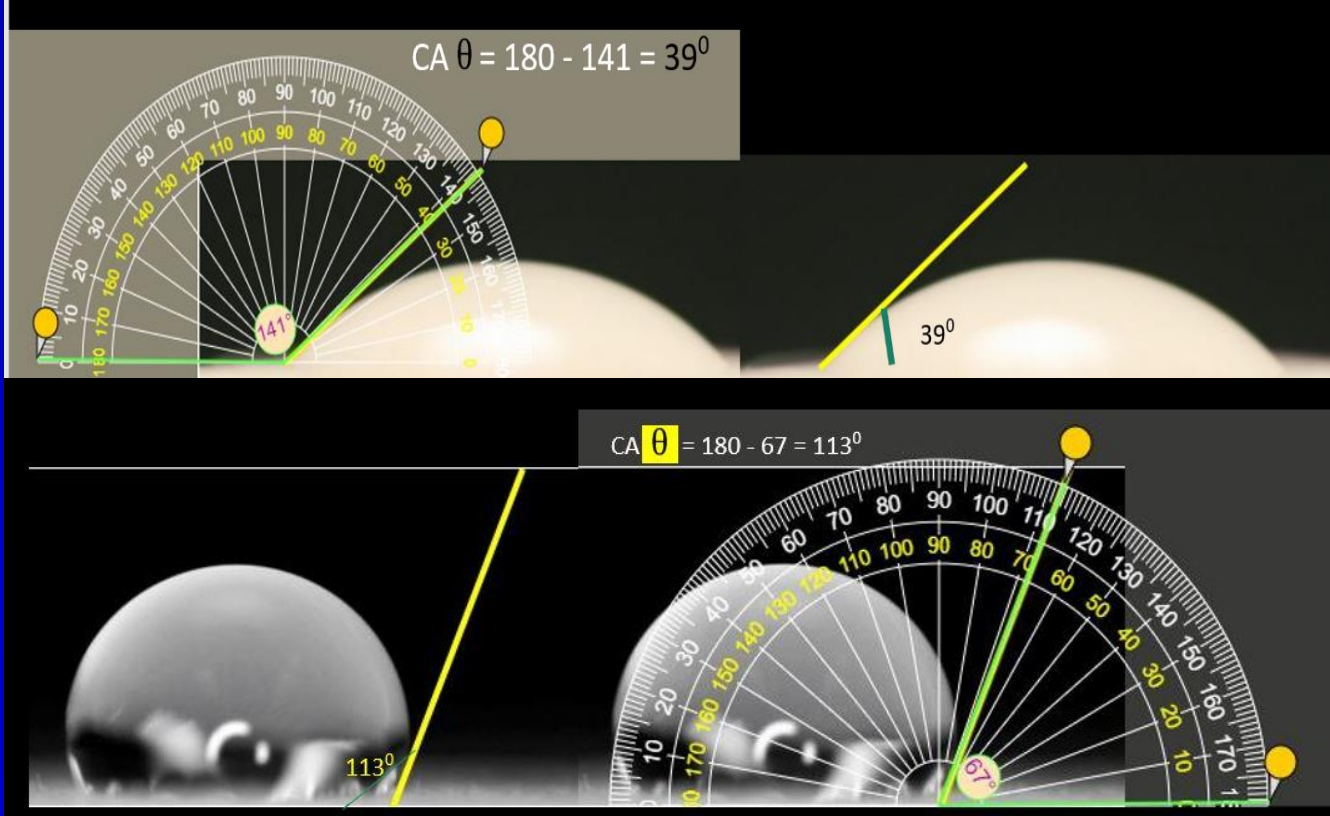


Figure 4A & B Illustrated a hydrophilic surface (porcelain) and a hydrophobic surface (Teflon).

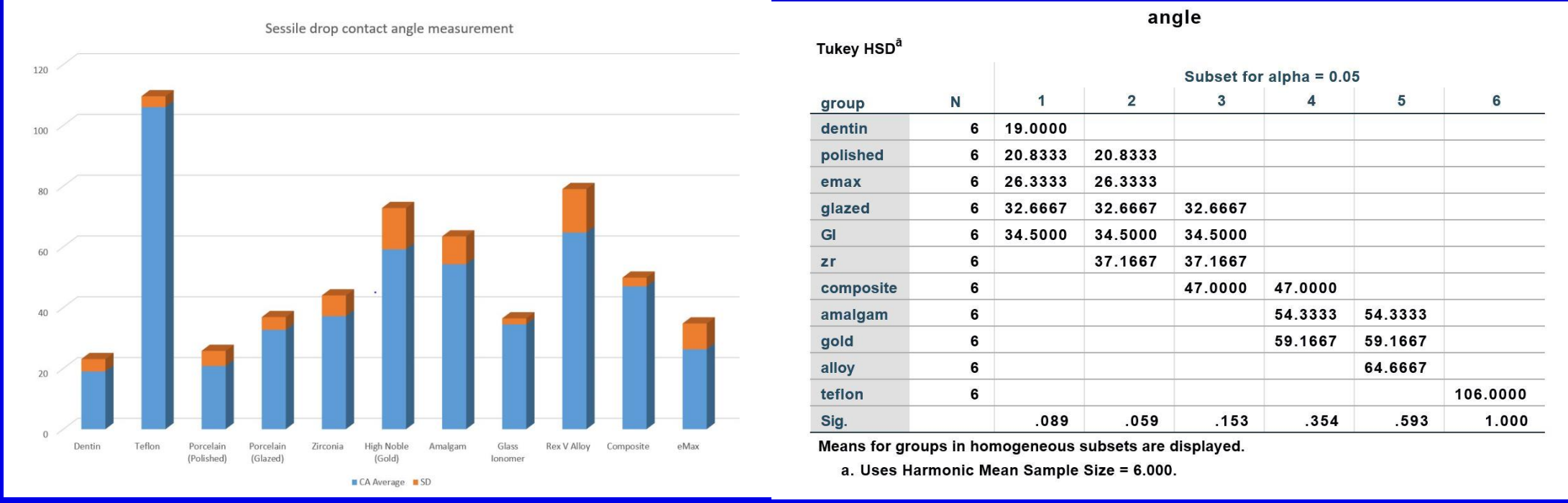


Figure 5. Contact angles measured using the sessile drop technique

Result: *Live and dead cells measurement* Live and dead cell counts (Figures 3,4) after 48-hour revealed that gold casting alloy, amalgam, and zirconia materials harbored low number both in live and dead cells. Based-metal alloy, resin composite, and lithium desilicated glass-ceramic surfaces retained significantly higher number of dead compared to the controls (dentin and Teflon). For biofilm formation, glazed porcelain, glass ionomer, Teflon, and human dentin surface consist of significantly higher bacterial growth.

Contact angles measurement Figures 5A and 5B illustrate images taken with camera of typical sessile drop experiments for porcelain (hydrophilic) and Teflon (hydrophobic) respectively. Our results show that the materials tested present different contact angles and can be explained by surface characteristics such as composition, fillers and topography. It appears that Teflon as a negative control showed the highest values when measured with water (106°) while dentin as a positive control yielded low contact angle values of 19°.

Conclusions: Within the limits of our study, we concluded that the techniques described are feasible and quick to study biofilm formation on biomaterials. Roughness is a significant factor. Other factors such as surface charges and energy, and chemical composition may also play a role. Understanding biofilm formation on restorations is crucial to dental clinicians.

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