# Development of biopolymer based bifunctional bioactive coatings to enhance metallic dental implants soft-tissue integration and prevent or treat peri-implantitis

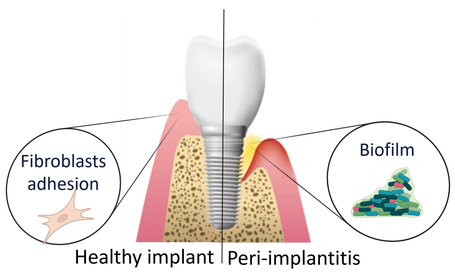
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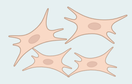
## INTRODUCTION

Peri-implantitis affects 20–45% of dental implants, threatening long-term implant success.



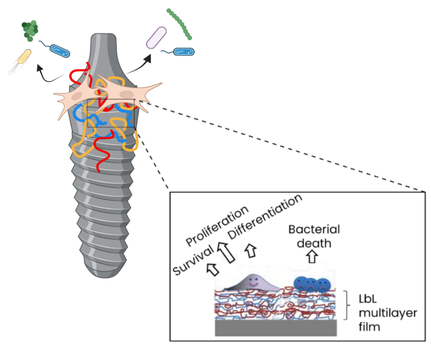

Its pathogenesis is driven by bacterial biofilm accumulation at the implant-soft tissue interface, that leads to progressive bone resorption.

- Current therapeutic approaches fail to prevent recurrence.
- Existing surface engineering strategies address antibacterial protection or soft tissue integration; no current strategy simultaneously addresses both challenges.

antibacterial  or  pro-adhesive

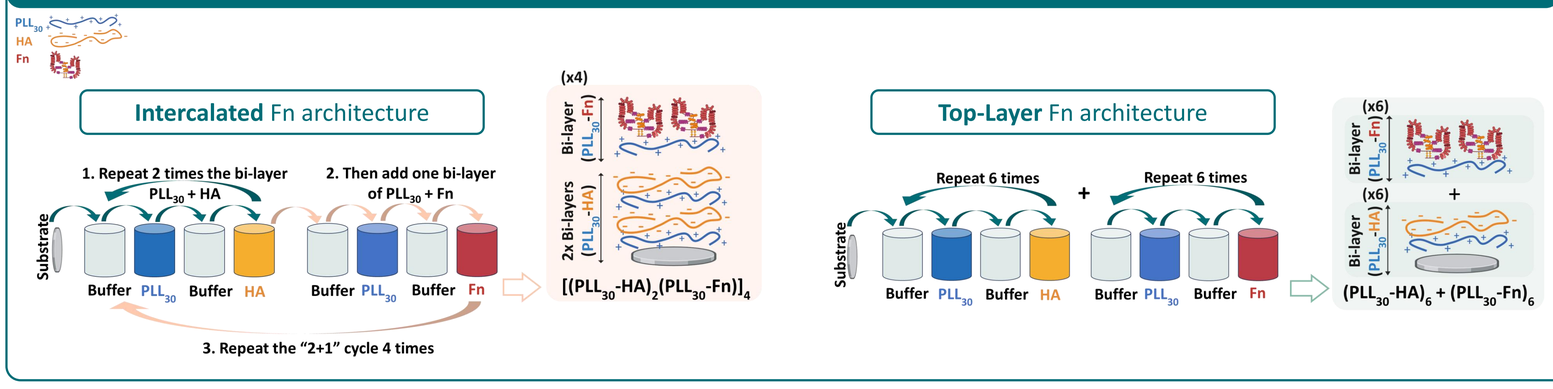
- Furthermore, existing deposition methods are incompatible with chairside clinical use.

## OBJECTIVE

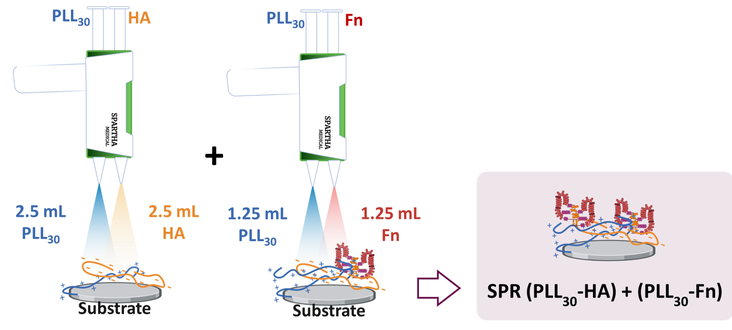



Develop a bifunctional and bioactive Layer-by-Layer (LbL) dip-coating combining both antibacterial and pro-adhesive properties and translate the optimized architecture to a rapid spray-assisted deposition suitable for chairside clinical application.

## From defining the spatial deposition by dip coating LbL assembly

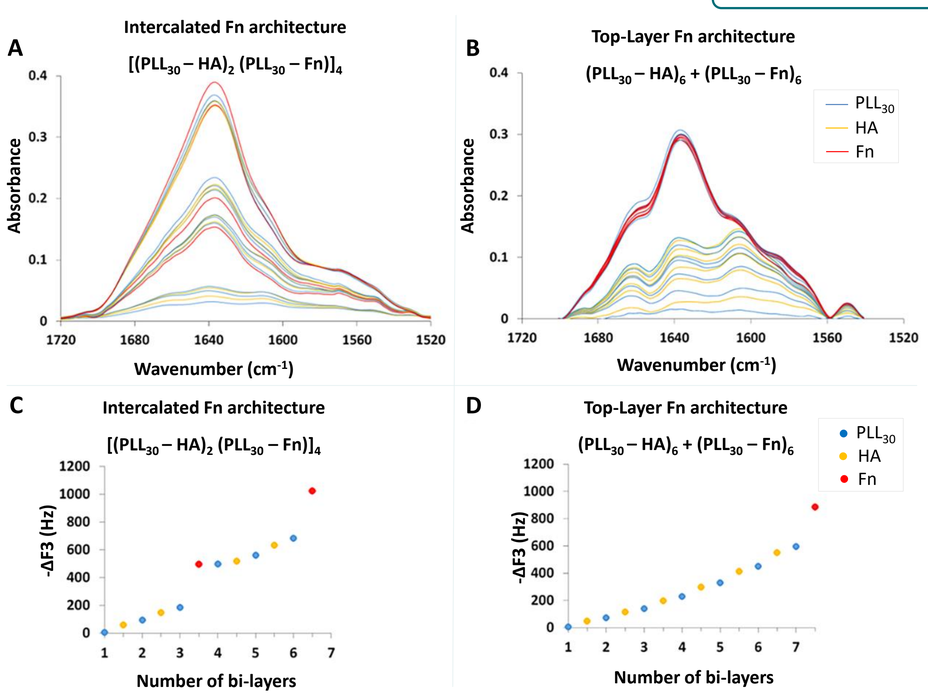



## To an innovative spray coating deposition



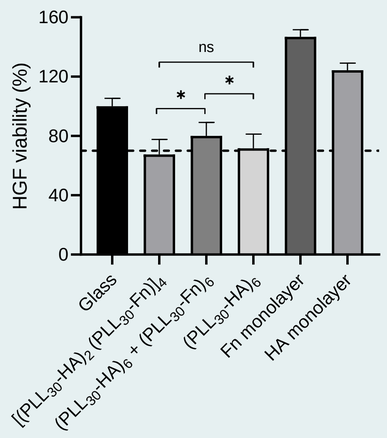

## RESULTS

### DIP COATING LBL ASSEMBLY

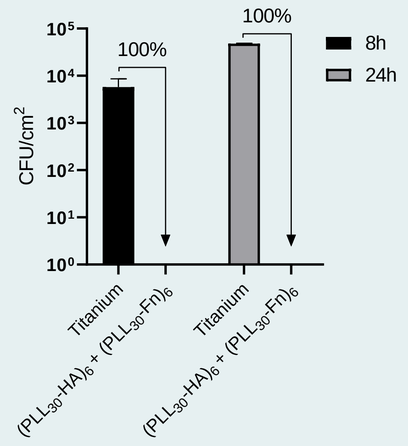



ATR-FTIR confirmed the successful multilayer buildup for both architectures, by following the amide I' band increase at each deposition, with high Fn adsorption.

QCM-D monitoring revealed **exponential growth kinetics** for both configurations, characteristic of short-chain polycation/HA systems.



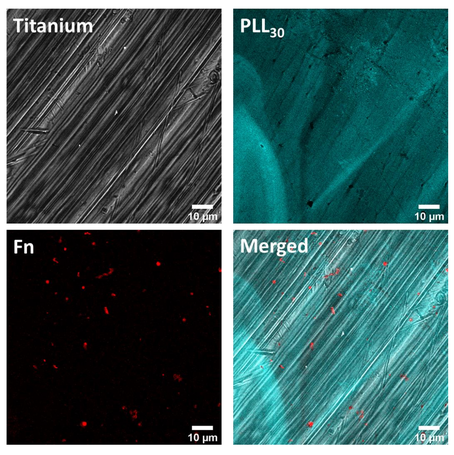

Cytocompatibility towards HGF revealed a critical divergence depending on Fn positioning throughout the film.



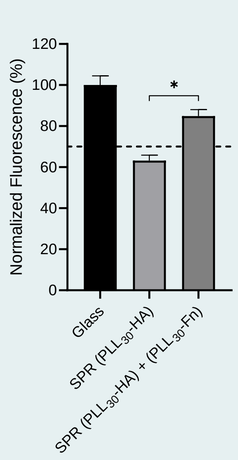

The **Top-Layer Fn architecture** achieved complete biofilm inhibition on titanium after 8h and 24h of contact with *Staphylococcus aureus.*

### SPRAY COATING DEPOSITION

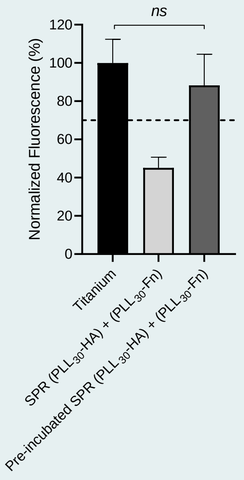
CLSM of SPR ($PLL_{30}$-HA) + ($PLL_{30}$-Fn) on titanium (Ti6Al4V-ELI) substrates with fluorescent $PLL_{30}$-FITC (cyan) and Fn-Alexa568 (red).



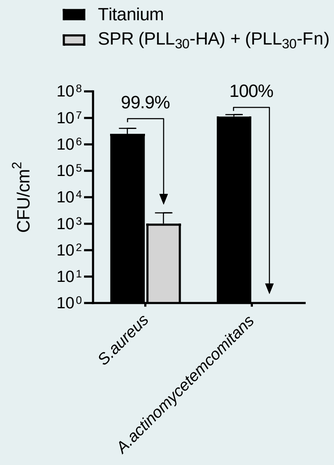

**Homogeneous coverage** of the coating across the surface: $PLL_{30}$ and Fn co-localize uniformly regardless of underlying substrate topography. Fn appears as aggregates.




Terminal Fn incorporation **enhanced early fibroblast response** on glass (85% vs. 63% without Fn, $p < 0.05$).




On titanium, FBS pre-conditioning — simulating physiological serum protein adsorption — raised Balb/3T3 viability from 45% to **88%.**




Spray-coated titanium achieved a **complete inhibition** against *A. actinomycetemcomitans* and a significant reduction against *S. aureus*.

## CONCLUSIONS

- Design of a single LbL coating architecture that simultaneously provides antibacterial protection and maintains a surface conducive to gingival fibroblast attachment by strategically combining $PLL_{30}$, HA and Fn in a stratified multilayer structure.
- Successful translation to an advanced spray-assisted deposition onto clinically relevant titanium surfaces.

## PERSPECTIVES

Rapid spray deposition enables two clinical scenarios:

1. **Preventive** — coating applied to sterile implants immediately before surgical placement
2. **Curative** — *in situ* application during peri-implantitis treatment, without implant removal

References:
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