

# Bioinspired Multifunctional Glass Surfaces Through Regenerative Secondary Mask Lithography

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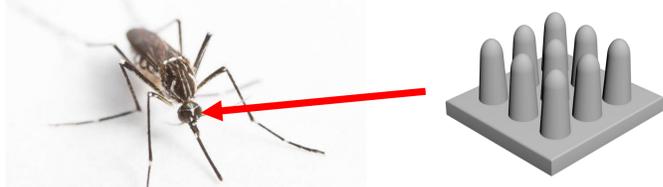


## ABSTRACT

Nature-inspired nanopatterning offers exciting multifunctionality spanning antireflectance and the ability to repel water/fog, oils, and bacteria; strongly dependent upon nanofeature size and morphology [1-3]. Broadly, it is inherent to and bridged by the **nanocone** structure, yet such patterning in glass ( $\text{SiO}_2$ ) – a material of great practical importance – remains a bottleneck due to its high chemical stability alongside structuring at the nanoscale itself, which becomes increasingly challenging to manage as the pattern resolution advances (pitch <100 nm). Here, we show a **facile approach for glass nanostructuring** and confirm that engineering superhydrophobic nanocones with enhanced impact-resistance, is achieved through: small pitch, tapered geometry, and uniform structuring [4]. To showcase the potential further, glass features are tailored to achieve: **high transparency, broadband, haze-free, omnidirectional anti-reflectivity (>97.5% transmission calibrated to human eye response)**; impact-resistant super-hydrophobicity (tested up to 4.4 m/s); and lastly, unique antibacterial properties on a glass surface towards *S. aureus* with a competitive >81% killing efficiency.

## MOTIVATION

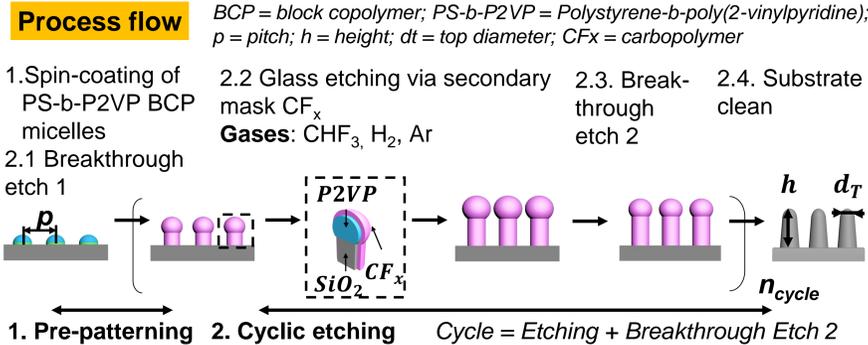
- Nature has arrived at extraordinary materials solutions to ensure survival by developing intricate surface patterns invisible to the naked eye
- These nanopatterns enable antireflectivity, self-cleaning, anti-biofouling, and anti-microbial properties amongst many others



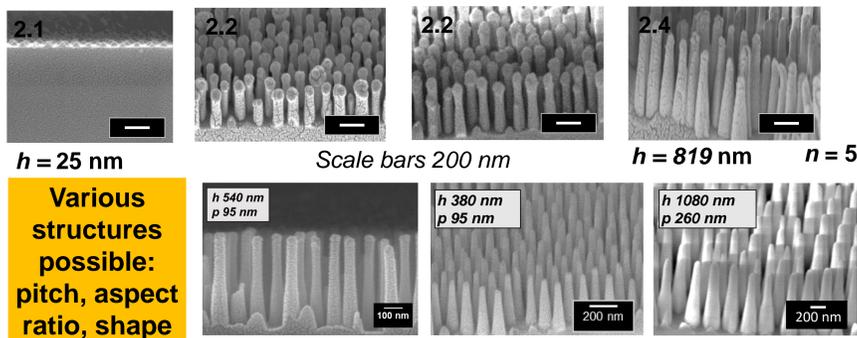
## NANOCONES

- Generating these structures synthetically is a challenge, particularly in glass – owing to its high stability
- This challenge is amplified when aiming for high resolution and well-controlled nanopatterns
- But if achieved, offers great potential in targeting multiple properties at once in a material as ubiquitous as glass

## GLASS NANOSTRUCTURING

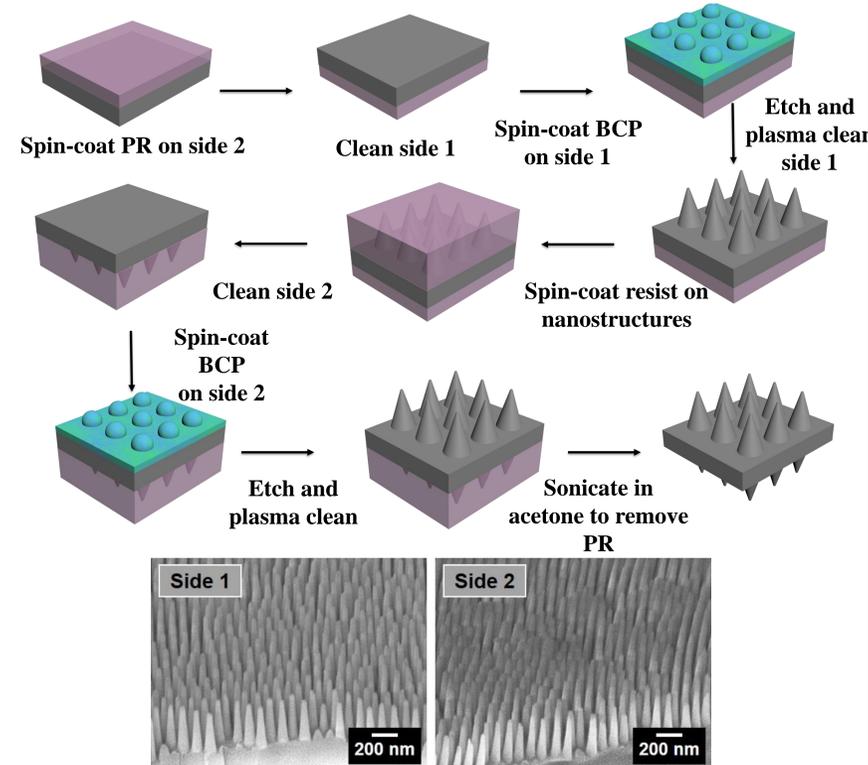


## Corresponding scanning electron microscopy (SEM) images

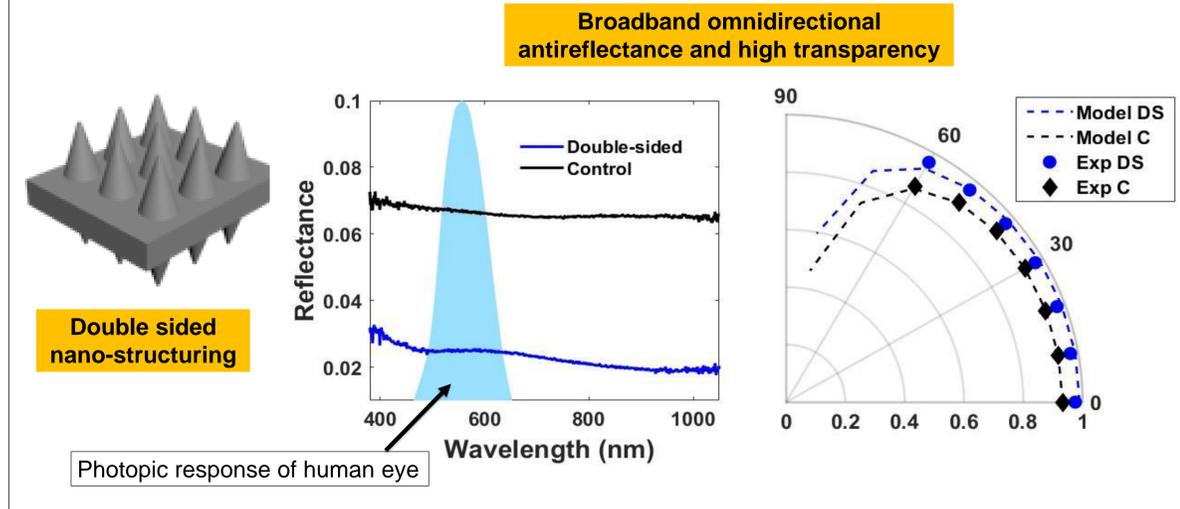


M. Michalska et al., Adv. Mat. (2021), 2102175.

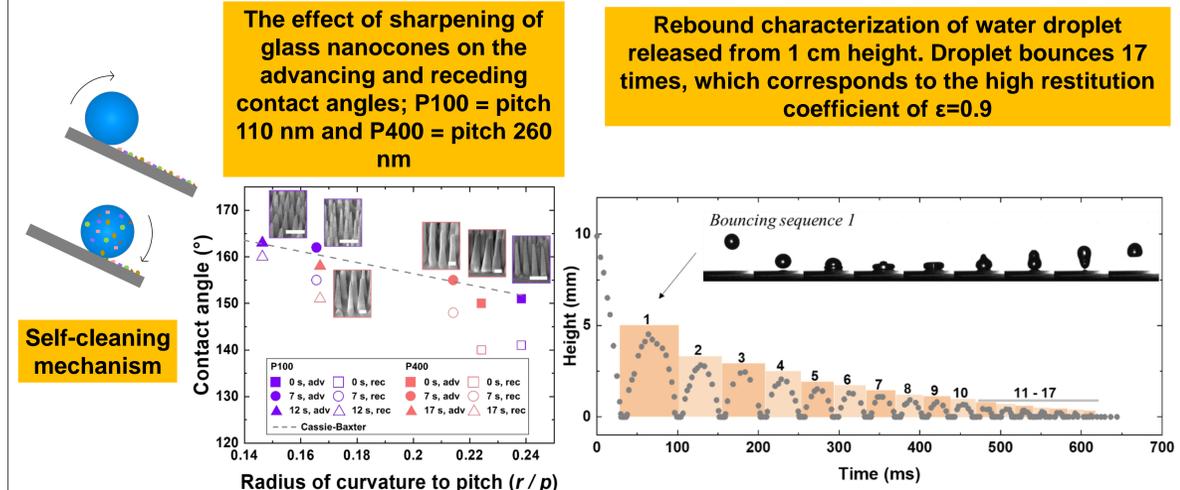
## DOUBLE SIDED NANOSTRUCTURING



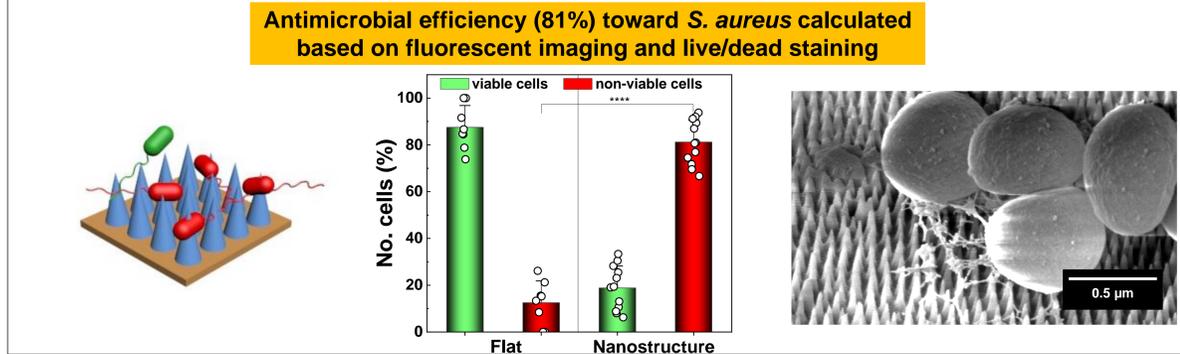
## OPTICAL PROPERTIES



## WETTABILITY: SELF-CLEANING



## ANTIMICROBIAL ACTIVITY



## CONCLUSIONS

- Our process enables fine nanostructuring of glass, unlocking tuning of multifunctionality
- Each functionality acts symbiotically to boost the overall optical performance; ensuring dust/pollution and microbes do not hinder the optical transparency/antireflectivity.

## REFERENCES

- [1] MJ Kreder et al., Nat. Rev. Mater.1(2016), 15003. [2] T Mouterde et al., Nat. Mater.16 (2017), 658.  
[3] DP Linklater et al., Nat. Rev. Microbiol.19(2021), 8. [4] M. Michalska et al., Adv. Mat. (2021), 2102175.

