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Introduction

Biomaterial-associated infections pose a severe threat to orthopedic success, as bacterial colonization often leads to biofilm formation. Preventing early attachment is therefore critical for infection control. Soda-lime silicate (SLS) glass is a promising biomaterial because of its biostability, lightweight, and biocompatibility. Here, we investigate a high-silica SLS glass (75 mol% SiO₂), whose dense network connectivity provides chemical biostability in physiological media. Beyond protective chip coatings and lenses, this non-resorbable matrix offers distinct clinical value as a permanent bone filler for specialized applications requiring long-term mechanical support and volume retention.

Methods

Project aims

Determine bacterial attachment and viability (*S. aureus* and *K. pneumoniae*) on SLS glasses.

Investigate the influence of ZnO substitution on bacterial colonization and antimicrobial performance.

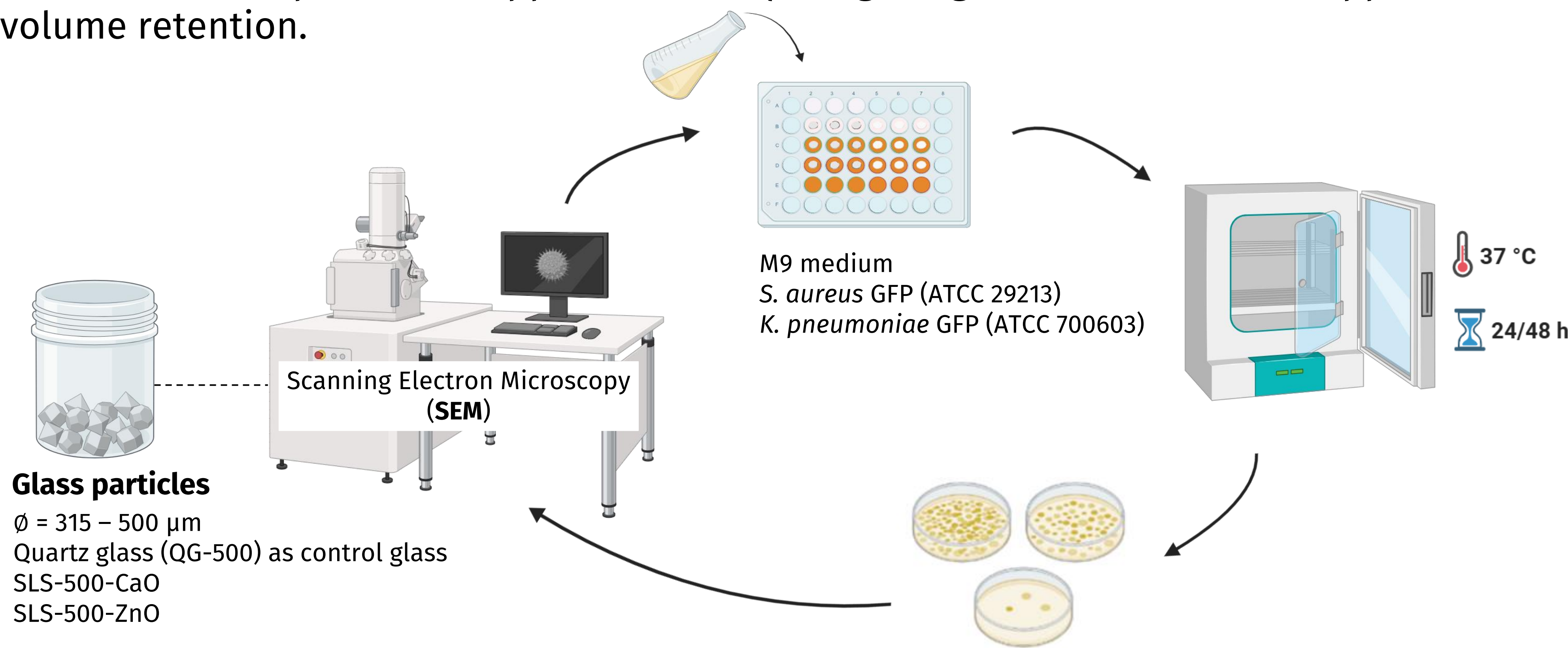


Fig. 1. Test performance.

Quartz glass (QG) was used as the control to evaluate the antimicrobial activity of SLS glasses. SLS and QG particles, provided by our collaborator, were first characterized by scanning electron microscopy (SEM). The particles were then incubated with GFP-labelled *S. aureus* (ATCC 29213) and *K. pneumoniae* (ATCC 700603) for 24 or 48 h. Following incubation, biofilms were detached for colony-forming unit (CFU) quantification. Finally, SEM was performed to assess biofilm formation and examine any surface changes after bacterial exposure.

CFU quantification

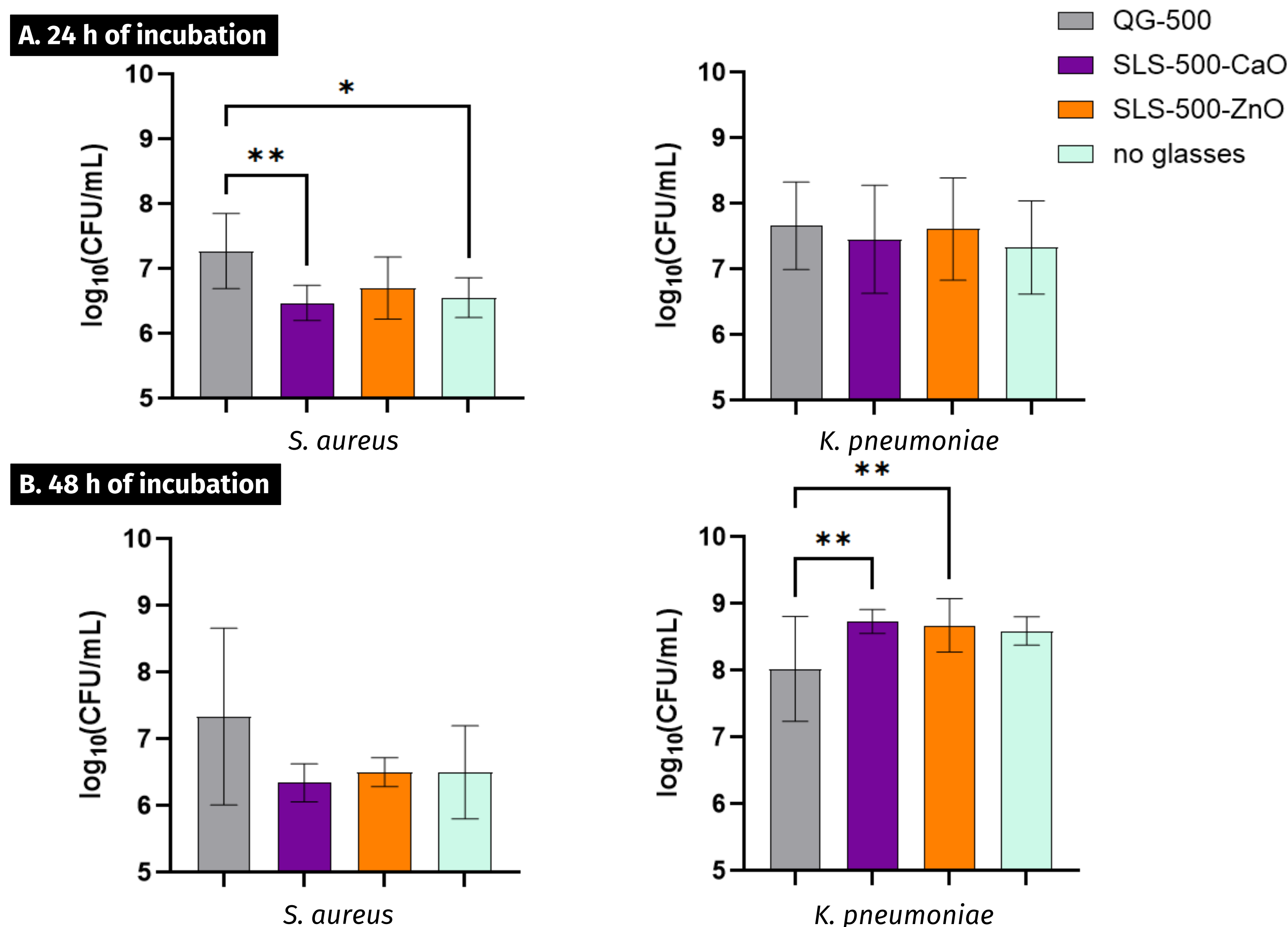


Fig. 2. CFU counts.

A. 24 h: *S. aureus* CFUs were lower on SLS-CaO compared to QG, with no difference between SLS-CaO and SLS-ZnO. No significant differences were observed for *K. pneumoniae*.

B. 48 h: *S. aureus* showed lower CFUs on SLS-CaO, suggests persisting anti-adhesion, but high variance in the QG control masks statistical significance. No differences were found between SLS-CaO and SLS-ZnO. *K. pneumoniae* showed significantly higher CFU counts on both SLS glasses.

In summary, SLS glasses showed minor pathogen-specific anti-attachment against *S. aureus*, while QG induced *K. pneumoniae* filamentation.

CFU results (Fig. 2): reduced *S. aureus* attachment was observed on SLS glasses; ZnO substitution showed no significant improvement.

SEM results (Fig. 3): QG induced *K. pneumoniae* filamentation, explaining lower CFU counts. Conversely, the SLS glass allows normal, uninhibited bacterial division, resulting in higher CFU counts.

Outlook: To fully resolve 3D biofilm structures and architecture on these glasses, future analyses will utilize confocal laser scanning microscopy.

SEM measurement

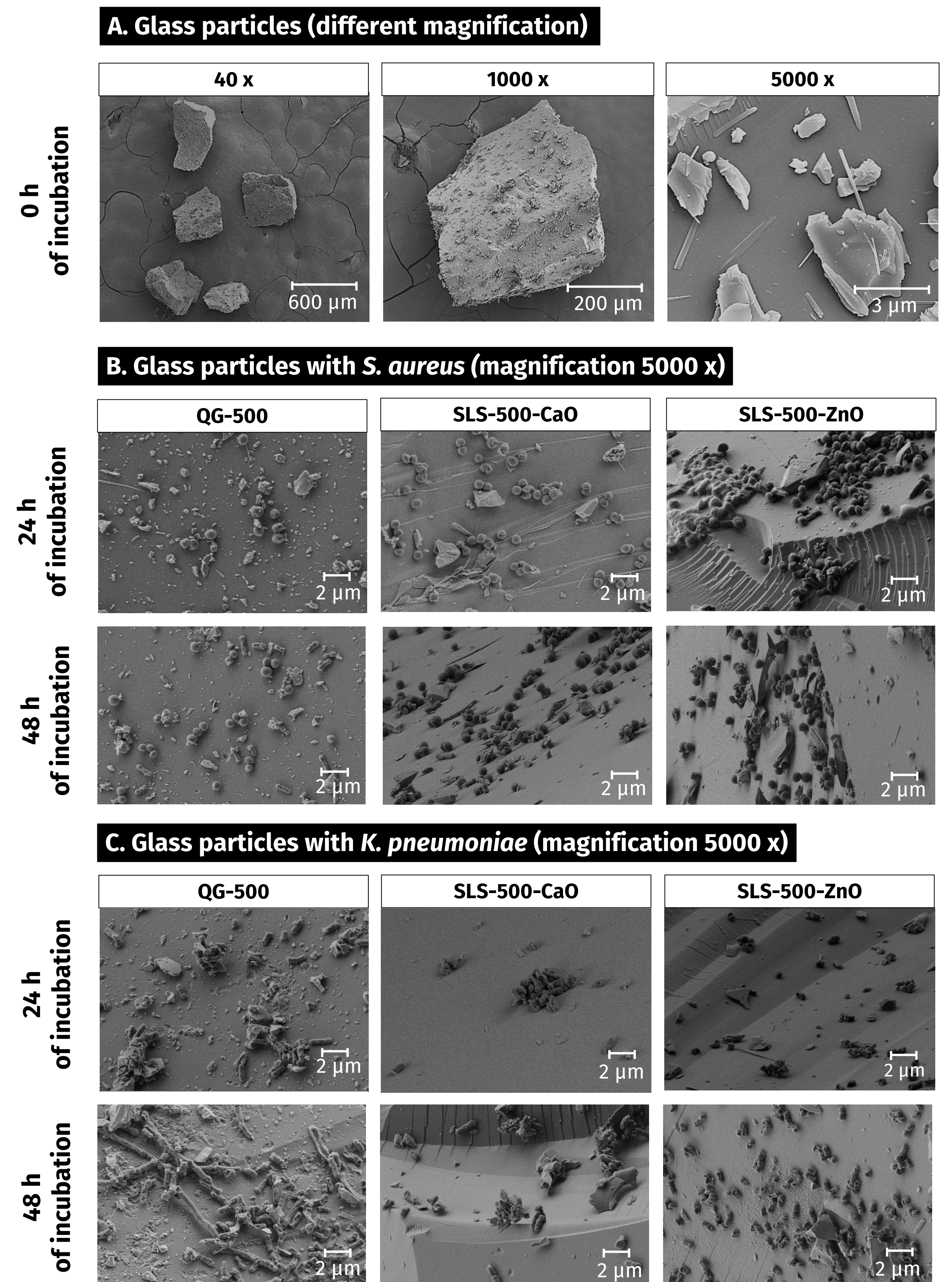


Fig. 3. SEM images of *S. aureus* and *K. pneumoniae* biofilm.

0 h: Pristine glass particle surfaces before inoculation.

***S. aureus*:** Coccoid morphology successfully colonized all surfaces. Extracellular matrix was visible on SLS-ZnO after 24 h

***K. pneumoniae*:** Rod-shaped bacteria formed biofilm. Filamentation was observed on QG at 48 h, while SLS glasses showed normal cell division.