Rapid Evaluation of Antibacterial Activity by Microtiter Well Coating.

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RAPID EVALUATION OF ANTIBACTERIAL ACTIVITY BY MICROTITER WELL COATING

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The colonization of clinical and industrial surfaces with microorganisms, including antimicrobial-resistant strains, has promoted increased research into the development of effective antibacterial and antifouling coatings. In this study the preparation of metal (Ag\(^+\)) and metal oxide (Cu\(^{2+}\), Zn\(^{2+}\)) doped methyltriethoxysilane (MTEOS) coatings and the rapid assessment of their antibacterial activity is described. The wells of polystyrene microtiter plates were coated using various volumes of the sol-gels and cured at different temperatures for varying time periods. Curing parameters were analyzed using thermogravimetric analysis (TGA) and visual examination. The optimum curing temperature in the microtiter wells was determined to be 50-60\(^\circ\)C. when the wells were coated using a sol-gel volume of 200 \(\mu\)l. The coated wells were challenged with cultures of Staphylococcus aureus, Staphylococcus epidermidis and Escherichia coli. Silver showed the highest antibacterial activity followed by zinc and copper. DLS showed that the size of the silver ions was smaller than that of the zinc and copper. The silver doped sol-gel had broad spectrum antibacterial activity making it potentially useful as a coating for biomaterials. The use of microtiter plates enabled a variety of sol-gel coatings to be screened for their antibacterial activity against a wide range of bacteria in a relatively short time. This route is a pre-screening technique that then applied to the surface of indwelling items (e.g. ear-rings), in which the continuous release of metal and metal oxides has ability to protect skin surfaces from microbial infection.
Determination of the sizes of metal species by Dynamic Light Spectroscopy (DLS)

Experimental

In the analysis of metal species using Dynamic Light Spectroscopy (DLS), the sizes of metal species were determined. This method is useful for characterizing the size and shape of nanoparticles and other colloidal particles.

Antibacterial Activity:

The antibacterial activity of silver, copper, and zinc doped sol-gels was evaluated against a range of Gram-positive and Gram-negative organisms. The minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) were determined for each metal.

Results and Discussion

Analysis of curing Parameters

The curing parameters of the sol-gel coatings were optimized using various volumes of the sol-gels. The optimum curing parameters were determined using TGA (Fig. 2) followed by visual examination.

To avoid deformation of the microtiter plate, temperatures above 70°C were avoided. Low volumes of sols were found to have poor film forming properties with cracking occurring below 100 µl.

Assessment of antibacterial activity

The antibacterial activity of metal-doped sol-gel coated microtiter well was assessed against Gram-positive (Staphylococcus aureus ATCC 25923 and Staphylococcus epidermidis ATCC 41498) and Gram-negative (Escherichia coli ATCC 25922) organisms. Various sols volumes were dropped into a 96 well microtiter plate and cured at a TGA determined temperature.

Characterisation:

Thermogravimetric analysis (TGA) of the sols was carried out using a Shimadzu DTG 60 under a nitrogen flow of 40 mL/min. Dynamic light spectroscopy was performed using a Malvern nanosizer.

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Conclusion

The rapid evaluation of metal doped sol gel coatings in microtiter wells has been presented. The technique gave highly reproducible MIC data where the silver doped sol-gel coatings exhibited significant antibacterial activity against all the test organisms, followed by zinc and copper respectively.

Acknowledgement

The authors wish to acknowledge Dublin Institute of Technology, Dublin, Ireland for funding under the ABBEST scholarship programme and Enterprise Ireland under the ARE Programme.