Bacteria-nanoparticle interaction based on functionalized surfaces

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Abstract

Silica nanoparticles were synthesized and functionalized with different chemical groups (hydroxyl, mercapto, isocyanate, carboxyl and amino) in order to understand how different functional groups favor the interaction between nanoparticles and the envelope of different bacteria. Obtained results showed that bacteria-nanoparticle interation is driven by the nature of nanoparticles surface and that different types of bacteria envelope do not influence this mechanism.

Nanometric structures, functionalization, bacteria interaction.

Introduction

Nanoparticles are being used as one of the most promising strategies to prevent bacterial growth and development. Due to their unique physicochemical properties, nanomaterials are able to interact intimately with bacteria. Therefore, this mechanism of interaction has been still unknown.[1-2] It is believed that it depends on the properties of the nanoparticles (such as size, aggregation state and functionalization of its surface) and also on the organization of the constituents of the bacterial cell envelope.[3]

Results and Discussion

Quantification of chemical groups present on the silica surface was determined by thermogravimetric analysis through distinct weight loss stages (Figure 1A). For SiO_2-OH and SiO_2-NH_2 samples, the weight loss between 180 ºC and 700 ºC is ~ 4.2% and ~ 5.6%, respectively. The difference ~ 1.4% between these samples is related to the -NH_2 group incorporated on the material surface. This is also valid for SiO_2-NCO and SiO_2-SH samples, which showed ~ 2.1% and ~ 4.2% of –NCO and –SH groups, respectively. For SiO_2-COOH, taking into account that SiO_2NPs-NH_2 were used as precursor for the synthesis, the difference between the weight loss of SiO_2-NH_2 and SiO_2-COOH is ~ 9.5% related to –COOH group. FTIR spectra (Figure 1B) confirms the functionalization success where bands attributed do different chemical groups can be identified. Incubation experiments (Figure 1C and 1D) with *Staphylococcus aureus* and *Escherichia coli* bacterium showed the following bactericidal efficiency trend: SiO_2-OH > SiO_2-COOH > SiO_2-NH_2 > SiO_2-SH > SiO_2-NCO. Bare nanoparticles and aliquots of nanoparticles incubated with bacteria were analyzed by scanning electron microscopy (SEM) and are presented in Figures 1E, 1F and 1G.

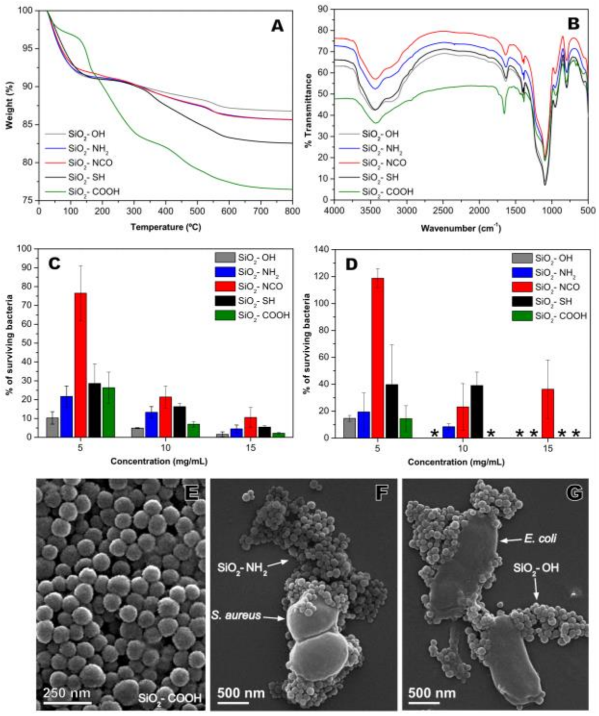

Figure 1. Results obtained for silica nanoparticles synthesis.

Conclusions

Bacteria-nanoparticle interation is extremely dependent on the the nature of nanoparticles surface which can be tailored to obtain strucutures with high batericidadal efficacy. Similar behaviors were seen when different types of bacteria cell envelopes where compared.

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