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Antibacterial Behaviour of a Silver-Doped Glass for Bone Surgery

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INTRODUCTION: The prevention of infections disease represents nowadays a central need, especially for prosthetic surgery. Many nosocomial bacteria, in fact, show an increasing resistance towards antibiotics, causing serious infections that lead to prolonged times of hospitalisation. The development of surfaces with low bacterial adhesion together with biocompatibility can represent a solution to prevent infections. Biocompatible glasses can be used to realize bone substitutes as well as coated metallic devices; moreover such materials can be opportunely treated to enrich their surfaces with silver ions [1] thus providing a controlled ion release and consequently antibacterial efficacy. Silver is, in fact, a well-known broad-spectrum antimicrobial agent, so silver-doped glasses can be produced to realize different devices, such as bone substitutes or coated metallic implants, with antibacterial action.

METHODS: A biocompatible glass composition was selected, processed by ion-exchange treatment to introduce a controlled amount of silver ions on its surface and, finally, characterized in terms of silver release in simulated body fluid solution (GF-AAS) and antibacterial activity (*S. Aureus* and *E. Coli*). Release tests were performed analyzing SBF at increasing times of contact with silver doped glass samples. Antibacterial tests evaluated bacteria adhesion on silver containing samples surfaces compared with untreated glass and PE control by means of colony forming unit (CFU) counts; moreover also culture medium was examined after samples incubation.

RESULTS: GF-AAS tests results are graphically shown in *figure 1*: the maximum amount of released silver ions is below 2μg/cm^2; release rate is higher for shorter times of SBF exposure to silver doped samples, reaching a threshold after about 500 hours. Antibacterial tests demonstrate, as evident in *figure 2* (only S. Aureus results are reported), that the introduced silver amount is sufficient to guarantee an antibacterial activity towards both *S. Aureus* and *E. Coli*.

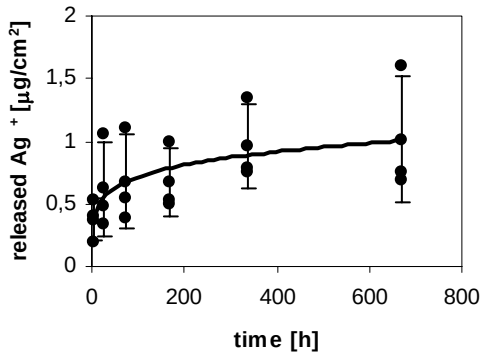

Fig. 1: GF-AAS measurements of silver ions released from doped glass samples into SBF solution.

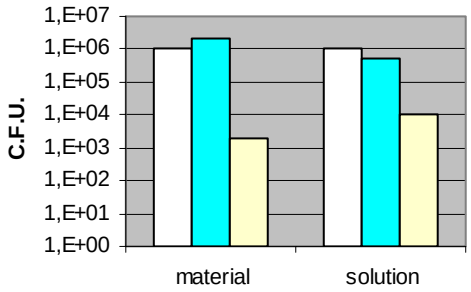

Fig. 2: C.F.U. counts after 24 hours incubation of S. Aureus on PE control (white bars), untreated glass (blue bars) and silver doped glass(yellow bars); both bacteria adhered on material surface and proliferated into culture medium were counted.

DISCUSSION & CONCLUSIONS: Release tests results are in accordance with literature data concerning safe concentrations for silver. Moreover the release rate trend shows that the stronger activity of silver is obtained immediately after contact with SBF solution; commonly, higher risks of infections occur immediately after surgical operations. Antibacterial tests demonstrates that silver doped glasses prepared by ion-exchange treatment are effective against *S. Aureus* and *E. Coli* adhesion onto material surface and proliferation in the surrounding culture medium: in both cases, in fact, C.F.U. decreased of at least 2 order of magnitude respect to control samples.

REFERENCES: [1] E. Vernè et al., *Surface characterization of silver-doped bioactive glass*, Biomaterials, **26**:25 (2005); pp. 5111-5119.