SILVER NANOPARTICLES FOR GENERATING CERAMIC SURFACES WITH GERMICIDE PROPERTIES

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ABSTRACT

The bacteriostatic additive **NANOSILVER AG®** is a colloidal dispersal of silver nanoparticles (AgNPs). AgNPs are able to create an antibacterial effect in treated ceramic surfaces and contribute permanent hygienic bacteriostatic properties to the vitreous surface.

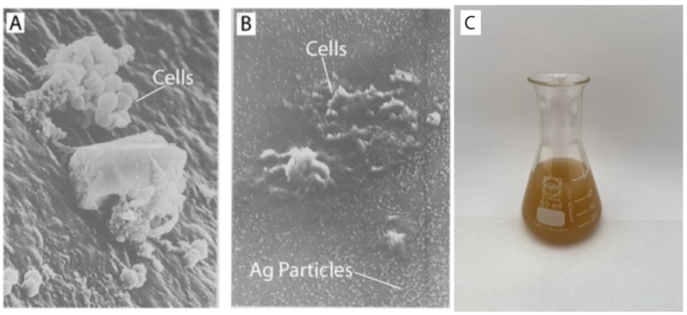


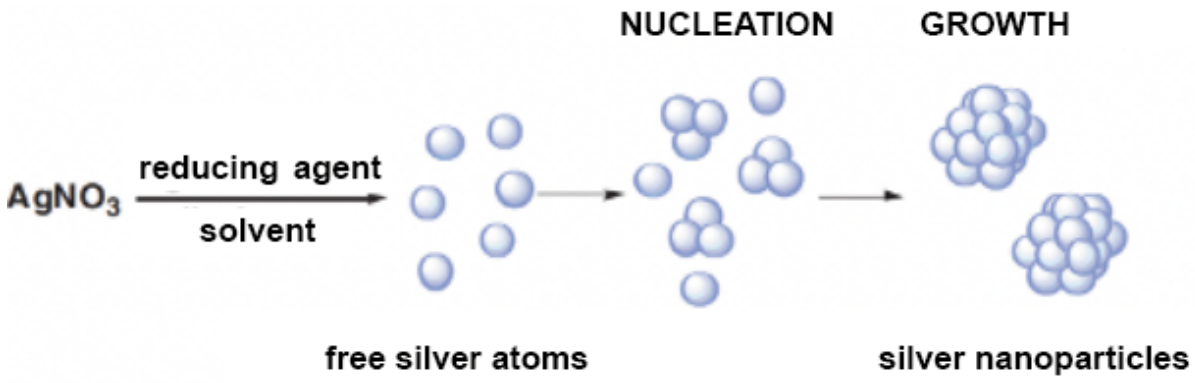
Figure A) *Staphylococcus aureus on an untreated surface. Figure B) Cell break-up on a surface doped with silver nanoparticles. Figure C) Visual appearance of Nanosilver AG.*

Exposure to AgNPs prevents cell proliferation[1] (Fig. 1). Treatment with silver of Staphylococcus aureus causes cell dehydration by damage to the membrane (Fig. 2).

METHOD AND GREEN SYNTHESIS

For the use and application of AgNPs in ceramics, Aditivos Cerámicos S.L. has opted for an aqueous synthesis method that meets the following requirements:

- Compatibility of the resulting product with ceramic formulations.
- Appropriate nanoparticle size for providing the ceramic surface with good antibacterial protection.
- Use of "green synthesis", minimising waste and resources using reducing agents and stabilisers of natural origin.



[1] J. R. Morones, J. L. Elechiguerra, A. Camacho, K. Holt., J. B. Kouri, J. T. Ramírez, M. J. Yacaman, *Nanotechnology,* **2005**, 16, 2346–2353

CHARACTERISATION OF THE AgNPs OBTAINED

Among the various characterisation methods[2] described in the literature for AgNP, the determination of the UV-Vis absorption spectrum appeared highly appropriate, as it is a non-destructive method that provides fast and accurate information.

The absorption spectrum of the product obtained in our synthesis exhibited a band corresponding to surface plasmon with a maximum at 412 nm (Fig. D), which was consistent with the existence of small-sized spherical nanoparticles.

Diameter	nm λ_{max}
10	392.1
20	400.8
30	405.6
40	412.3
50	420.9
60	431.5
70	443.8
80	458.3
90	474.6
100	492.8

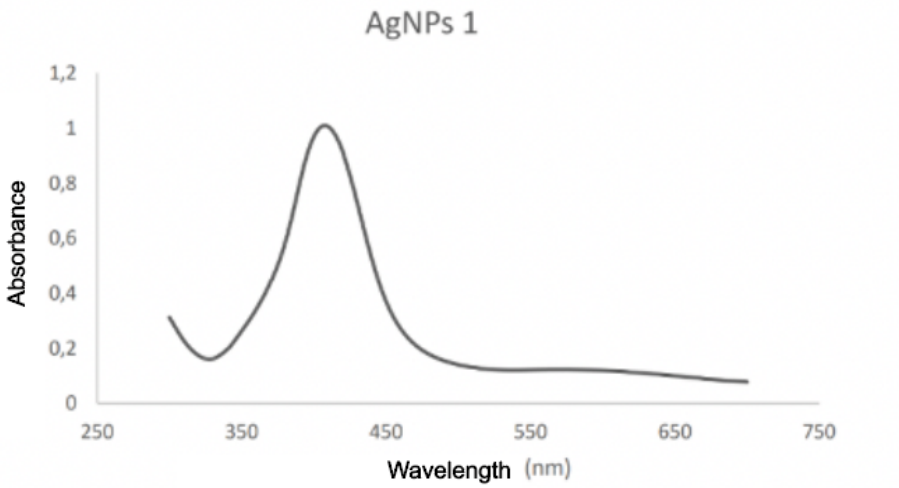


Figure D) *absorption spectrum of the synthesised AgNPs.*

This experimental observation was compared with X-ray diffraction (XRD) analysis (Fig E) and scanning electron microscopy (SEM) (Fig. F).

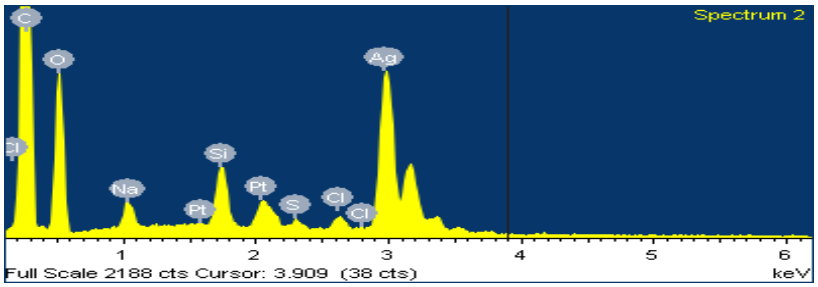


Figure E) *elementary analysis by XRD.*

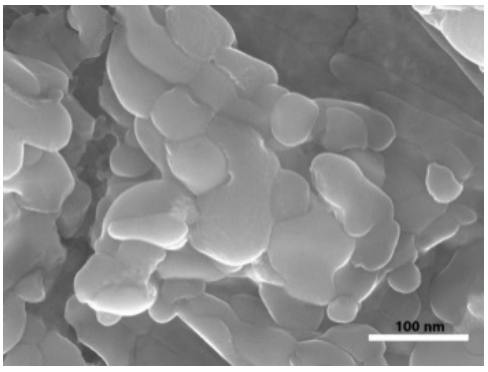


Figure F) *mounds of AgNPs in the product after calcining the polymer coating (SEM route).*

[2] Xi-Feng Zhang, Zhi-Guo Liu, Wei Shen, and Sangiliyandi Gurunathan "Silver Nanoparticles: Synthesis, Characterization, Properties, Applications, and Therapeutic Approaches" *Int J Mol Sci.* **2016** Sept; 17(9): 1534.

APPLICATION

AgNPs are able to provide surfaces with bactericidal properties. This effectiveness has been validated for different ceramic industries:

- Floor tiles, wall tiles, and trims or special pieces
- Ceramic sanitary ware and tableware
- Ceramic worktops and large sizes



ADVANTAGES OF USING AgNPs IN CERAMICS

- ✓ Minimum impact on final cost
- ✓ High effectiveness with low proportioned quantities
- ✓ Permanent antimicrobial effect
- ✓ The original design is maintained
- ✓ Thermal stability above 1300ºC
- ✓ Non-allergen. Causes no cutaneous sensitivity
- ✓ UV lightfast and lasts on the substrate
- ✓ Resistance to abrasion and cleaning in flooring