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# Antibacterial activity of nanosilver by ions and particles

by

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Figure S1 shows an exemplary STEM image of *10Ag/SiO₂* and the nanosilver particle size distribution (inset) along with its average size, geometric standard deviation and total number of nanosilver particles counted. The nanosilver particles are homogeneously dispersed on amorphous $SiO_2$ and exhibit a unimodal size distribution.

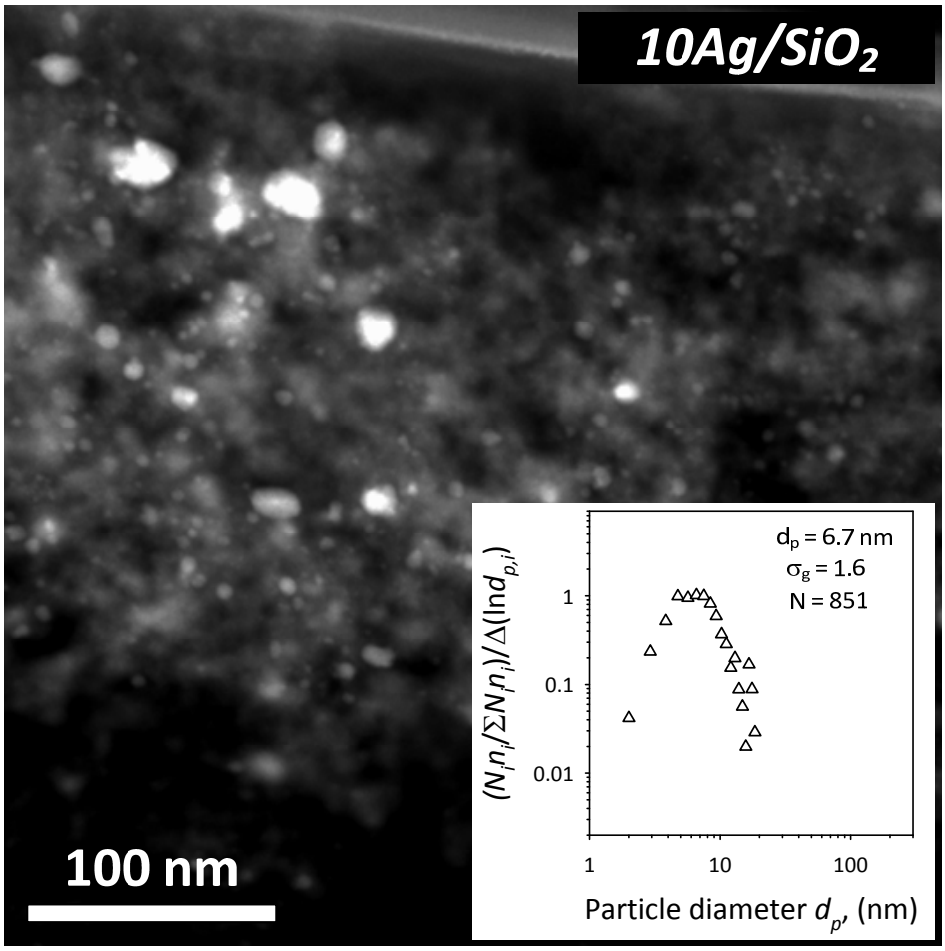


**Figure S1.** STEM of *10Ag/SiO₂* with a unimodal nanosilver size distribution. The number average particle diameters $d_p$ and geometric standard deviations $\sigma_g$ and the number of nanosilver particles N are shown also.

Table S1 shows the summary of the XRD and S/TEM analysis of nanosilver of all composite *xAg/SiO₂* nanoparticles for *x* = 1-98 wt%. The average Ag crystal size $d_{XRD}$ is obtained from the X-ray diffraction spectra. Values are shown for *x* = 10-98 wt% as for smaller *x* the XRD could not determine reliably the Ag crystal content. Additionally, the average nanosilver particle diameter $d_{S/TEM}$ from S/TEM and its standard deviation along with the geometric standard deviation $\sigma_g$ of the distribution and the total number of counted

particles N is presented in Table S1 for all *x*. Good agreement is obtained between Ag $d_{XRD}$ and $d_{S/TEM}$ indicating that nanosilver immobilized on $SiO_2$ by FSP consists of monocrystalline Ag.

**Table S1.** Average Ag crystal diameter, $d_{XRD}$, and particle diameter, $d_{S/TEM}$, along with its standard deviation and geometric standard deviation, $\sigma_g$, and with the total number of counted Ag nanoparticles N in composite *xAg/SiO₂* particles made by flame spray pyrolysis (FSP).

| **Ag content *x* wt%** | **$d_{XRD}$ (nm)** | **$d_{S/TEM}$ (nm)** | **$\sigma_g$** | **N** |
|---|---|---|---|---|
| *1* | | 4.0 ± 2.0 | 1.60 | 203 |
| *2* | | 4.3 ± 3.2 | 1.45 | 445 |
| *6* | | 6.1 ± 3.1 | 1.70 | 165 |
| *10* | 6.9 ± 0.9 | 6.7 ± 4.1 | 1.61 | 851 |
| *25* | 8.1 ± 0.8 | 8.2 ± 3.4 | 1.42 | 326 |
| *50* | 8.7 ± 0.6 | 8.9 ± 3.5 | 1.45 | 744 |
| 75 | 10.8 ± 0.2 | 12.1 ± 4.0 | 1.40 | 544 |
| 95 | 14.6 ± 0.4 | 15.2 ± 4.4 | 1.33 | 608 |
| 98 | 15.1 ± 0.6 | 16.6 ± 3.8 | 1.35 | 178 |

Figure S2 shows the $Ag^+$ ion concentration evolution in aqueous suspensions containing *xAg/SiO₂* (*x* = 2-98 wt%) particles at constant C = 20 mg/L of Ag in solution. The time t = 0 corresponds to dispersion of *xAg/SiO₂* particles by ultrasonication in water. At all *x*, the equilibrium $Ag^+$ ion concentration is attained within a few minutes. The $Ag^+$ ion

concentration decreases with increasing Ag-content *x*, but each concentration is constant over time, within experimental uncertainty, regardless of *x*. This indicates that high Ag-content particles release much less $Ag^+$ ions upon dispersion in solution.

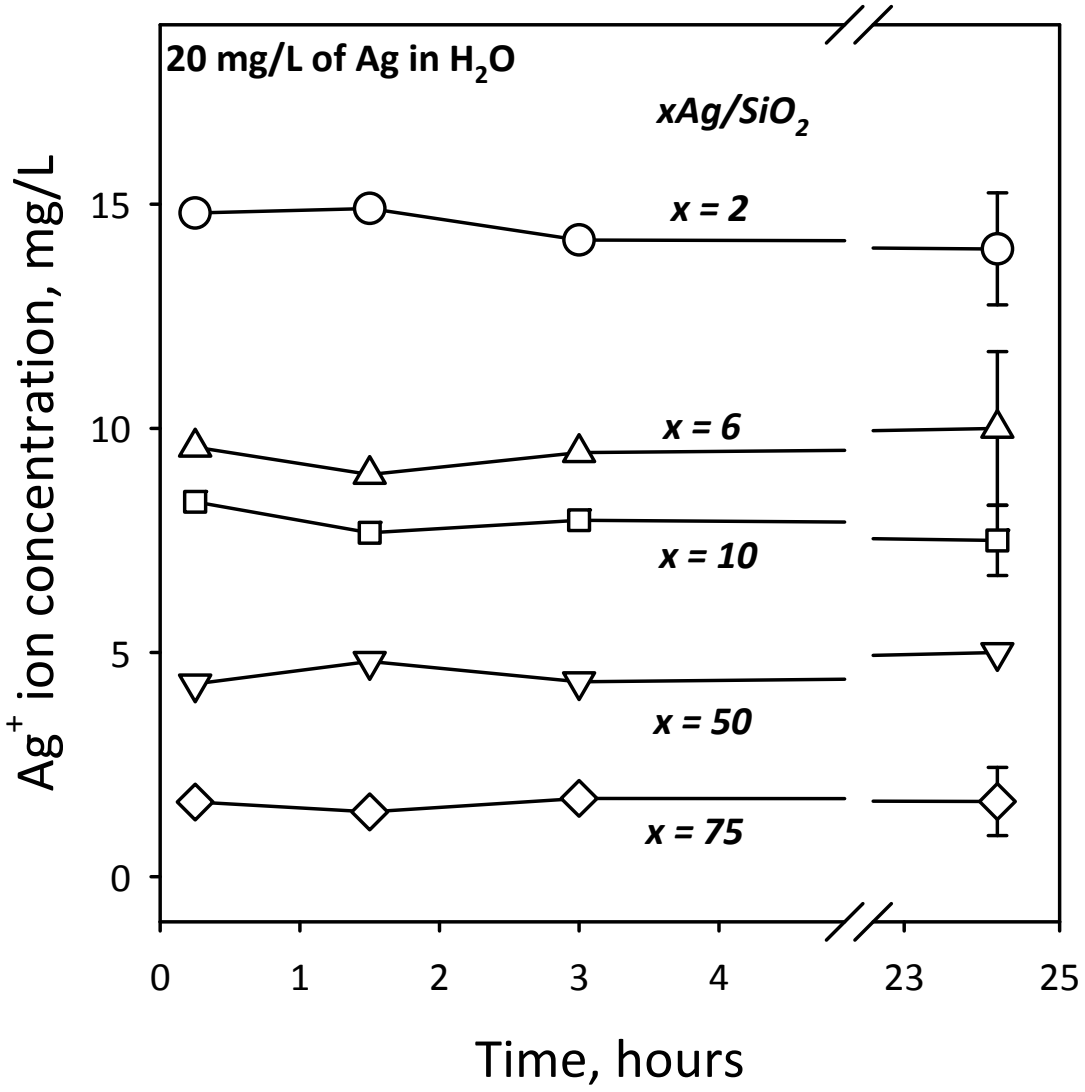


**Figure S2.** $Ag^+$ ion concentration of aqueous suspensions containing 20 mg/L Ag over time, with time t = 0 corresponding to that immediately after their dispersion.

Figure S3 shows the particle size distribution of *50Ag/SiO₂* composite nanoparticles measured by dynamic light scattering (DLS) in water immediately after dispersion and after 24 hours. It can be seen that the particle size distribution has practically remained the same over that period, indicating that the $Ag/SiO_2$ nanoparticles are stable in suspension during their antibacterial evaluation.

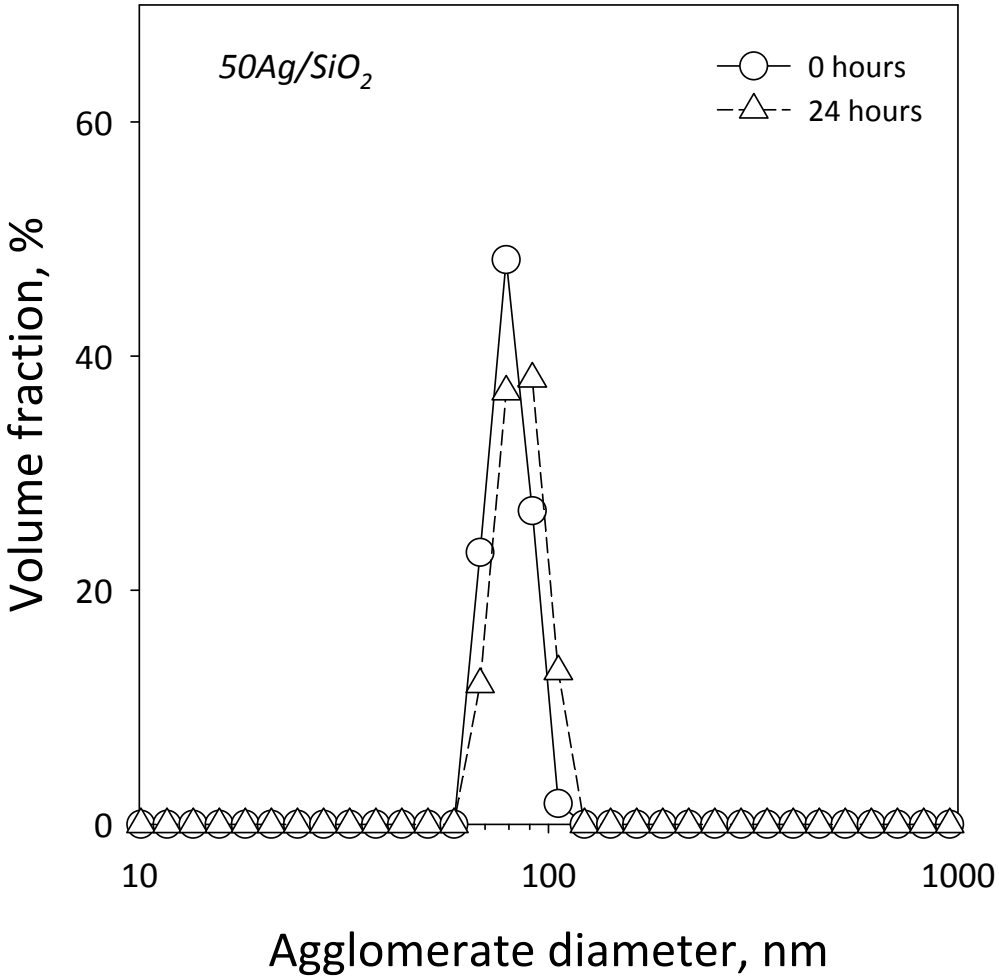


**Figure S3.** Dynamic light scattering of aqueous suspension containing the *50Ag/SiO₂* sample immediately after its dispersion and after 24 hours, indicating its stability.

Figure S4 shows the agglomerate volume size distributions of composite xAg/SiO2 nanoparticles for x = 1 – 95 wt% as determined by DLS in water. For an increasing Ag content *x*, the agglomerate size becomes smaller as the content of the fractal-like silica support is reduced [Kammler et al. 2004: Fig. 7].

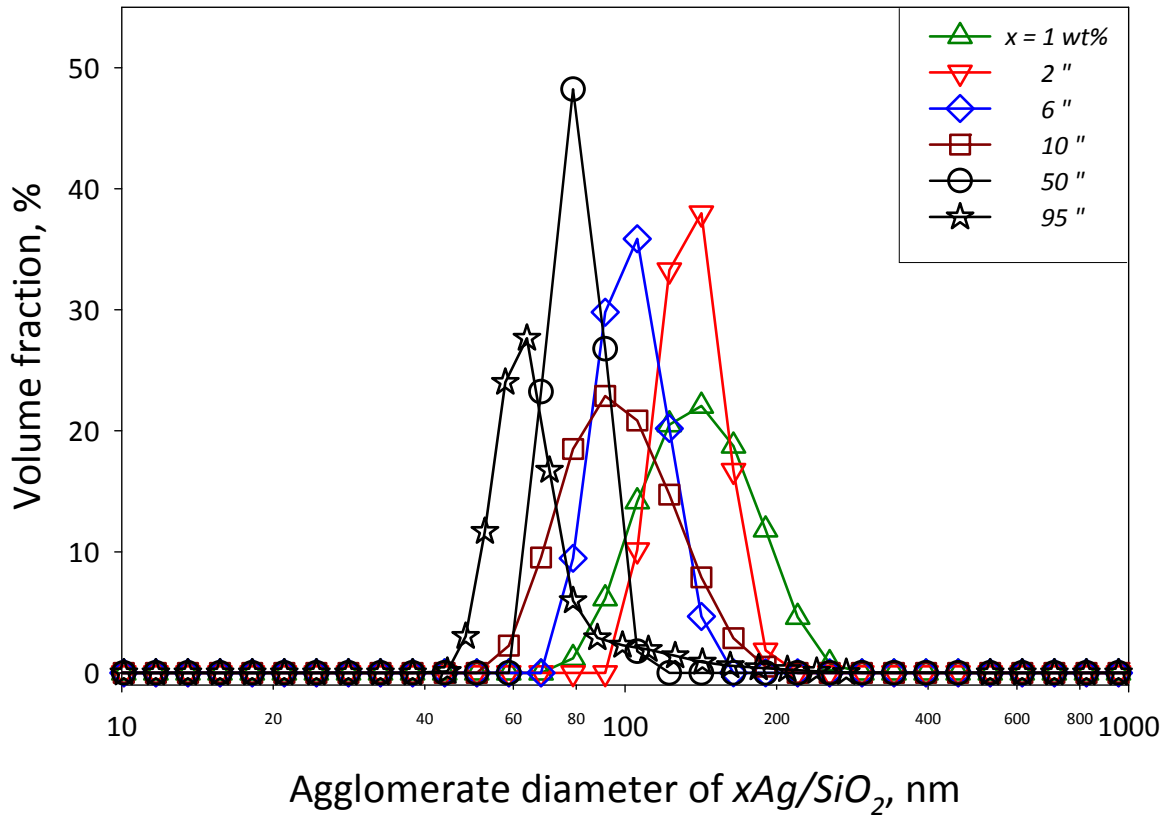


**Figure S4.** The agglomerate volume size distributions of composite $xAg/SiO_2$ particles for $x$ = 1-95 wt%.

## References

Kammler, H. K.; Beaucage, G.; Mueller, R.; Pratsinis, S. E. Structure of flame-made silica nanoparticles by ultra-small-angle X-ray scattering. *Langmuir* **2004,** *20*, 1915-1921.