Comparative study of biocidal activity of multicomponent nanocomposites on the base of (Ag, Au, CuO, CeO_2)-doped fumed silica

A.V. Vasin[1], S.V. Sevostianov[2], R.B. Kozakevych[2], V.A. Tertykh[2], K.S. Tsyhanenko[3], Ya.I. Savchuk[3]

[1]V.E. Lashkaryov Institute of Semiconductor Physics of NAS of Ukraine, 41 pr. Nauki, Kyiv 03028, Ukraine

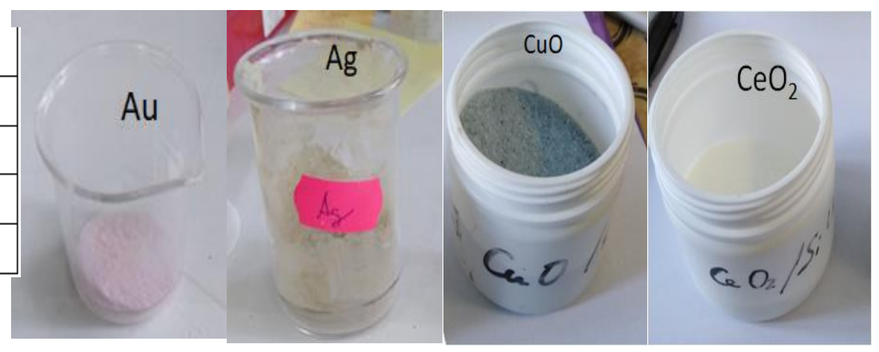
[2]Chuiko Institute of Surface Chemistry of NAS of Ukraine, 17 General Naumov str., Kyiv 03164, Ukraine

[3]Zabolotny Institute of Microbiology and Virology of NAS of Ukraine, 154 Acad. Zabolotny str., Kyiv 03143, Ukraine

(Corresponding author: Andrii Vasin av966@yahoo.com)

Ag, Au, CuO, and CeO2 nanoparticles were synthesized on the surface of fumed silica (specific surface 295 m^2/g) by reduction from salt solutions.

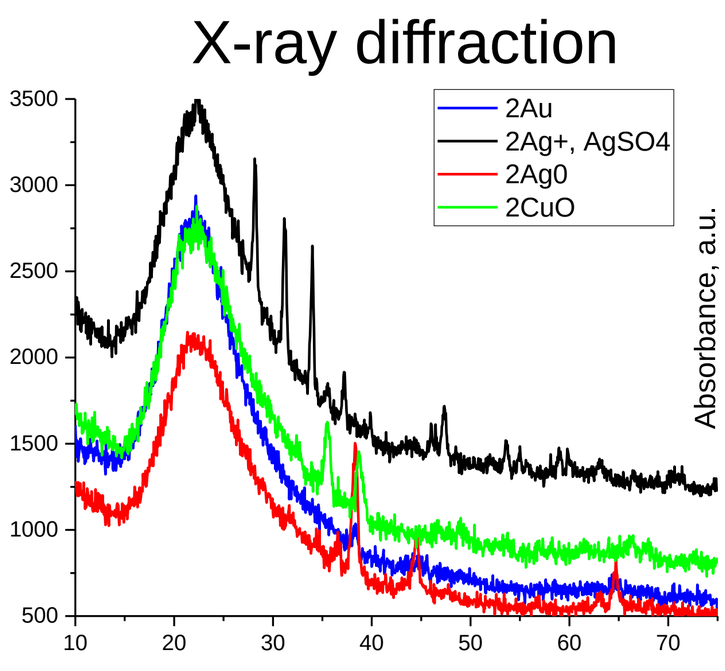
Composition	Precursor
CeO_2(5% wt.)/SiO_2	$Ce(NH_4)_2(NO)_3$
CuO(2,4% wt.)/SiO_2	$(CH_3COO)_2Cu$)
Ag(0,6% wt.)/SiO_2	Ag_2SO_4
Au(0,058% wt.)/SiO_2	$HAuCl_4$

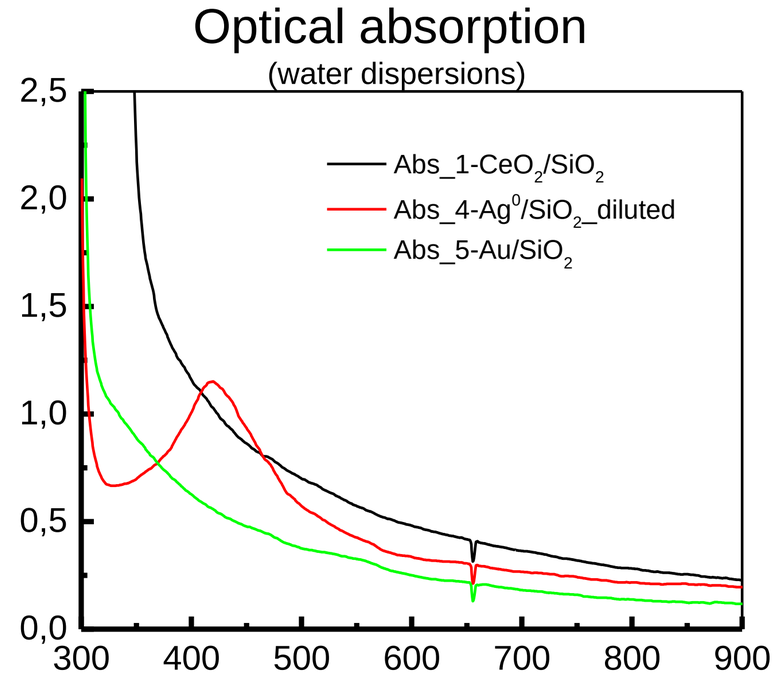


Powder samples of SiO2:nanoMe

Untreated fumed silica as well as fumed silica modified by organosilicons were used as solid state dispersion matrix.

The structures of the obtained nanoparticles were monitored using X-ray diffraction and optical absorption methods. Formation of nanoparticles is confirmed by X-ray diffraction. Formation of Ag, CeO2 and CuO nanoparticles has been additionaly confirmed by corresponding plasmon peak of nanoAg and absorption edge of CeO2 and CuO.

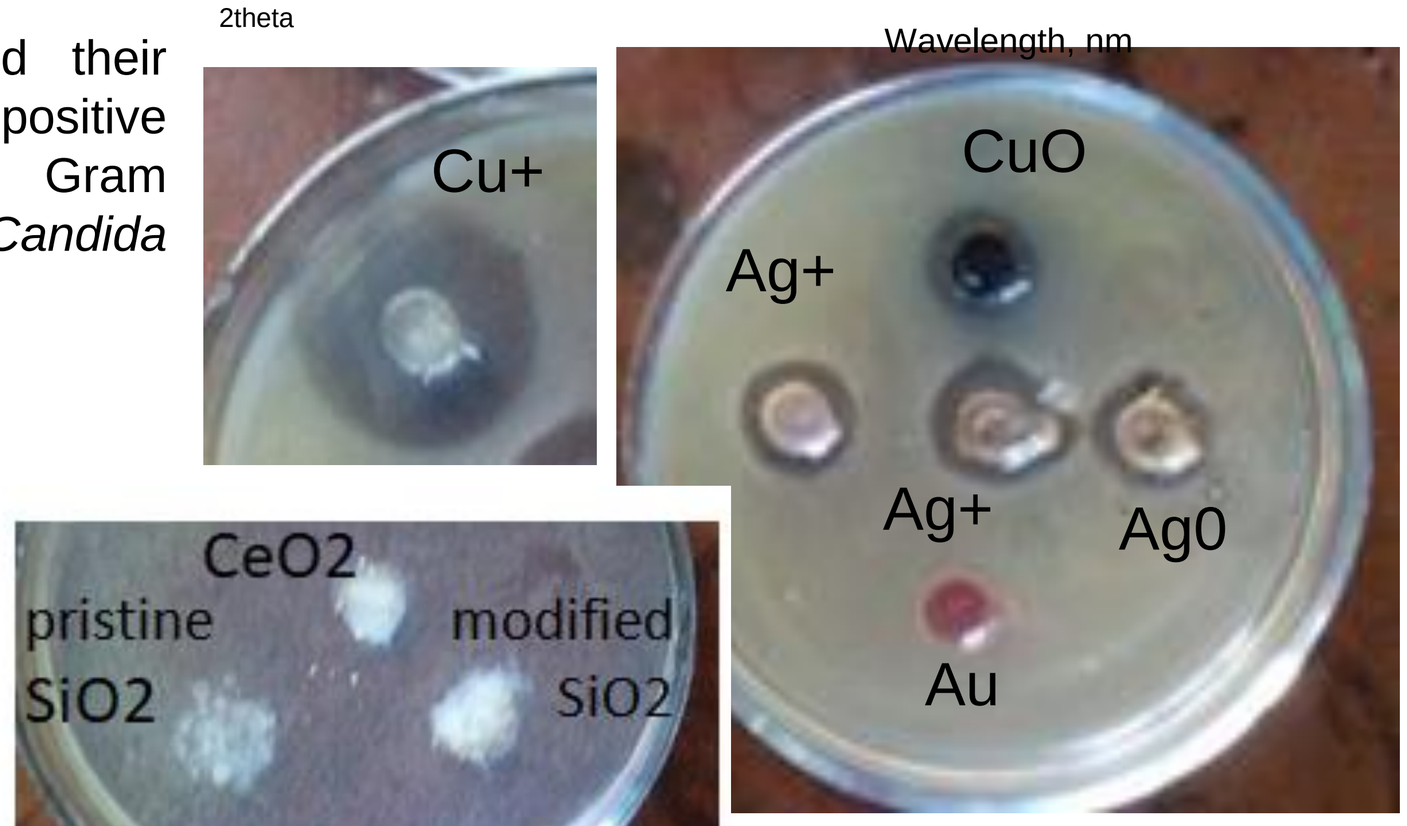




Biocidal activity of the nanocomposites and their aqueous dispersions was examined using Gram positive (*Staphylococcus aureus*, *Bacillus subtilis*), Gram negative (*Escherichia coli*) bacteria, and yeast (*Candida albicans*) by agar well diffusion method.

Biocidal properties of reference samples of pristine and modified fumed silica, which were used as a matrix, have been examined for correct evaluation of biocidal properties of the nanocomposites. As it can be seen from the right figure, no bioactivity was observed for matrix materials as well as for CeO2/SiO2 and Au/SiO2 nanocomposite.

In addition we have examined biocidal properties of nanosilica infiltrated by Cu+ and Ag+ to compare activity of solid state nanoparticles and metal ions in the same mass concentration.



Typical zones of inhibition for the case of *Staphylococcus aureus*

In case of copper the ion activity (CuSO4) was found to be significantly larger than for CuO nanoparticles. While in the case of silver the biocidl effects of free ions and nanoparticles were comparable.

Summary

Direct comparative analysis under identical test conditions showed that the activity of gold and cerium oxide nanoparticles is negligible compared to the activity of silver and copper oxide nanoparticles. It has been found the most active binary agents should be expected for the combinations of silver and copper oxide nanoparticles with silver and copper ions. Therefore, we suggest that further increase of biocidal activity can be reached by synergetic combination of metal/metal oxide nanoparticles with corresponding metal ions.