IOCC 2026 Conference
The 5th International Online Conference on Crystals
15–17 June 2026 | Online
MDPI

Design of Mono- and Multimetal Oxide Nanoparticles for Enhanced Antimicrobial Surface Applications

Kristijan Živković[1], Aleksander Učakar[2], Anamarija Stanković[3], Nives Matijaković Mlinarić[4]

•[1]Faculty of Science, University of Zagreb, Croatia [2] Institut Jožef Stefan, Slovenia [3] University of Osijek, Croatia [4] Ruđer Bošković Institute, Croatia

HRZZ Croatian Science Foundation
BIO-METONIC

INTRODUCTION & AIM

Why these nanoparticles?

Antimicrobial resistance requires durable, non-antibiotic surface materials. Metal oxide nanoparticles are attractive because of their stability and long-term antimicrobial potential [1,2]. This poster focuses on ZnO, CuO, Y_2O_3, and mixed CuO-ZnO-Y_2O_3 oxide nanoparticles as tunable antimicrobial platforms.

Aim: correlate precursor anion, synthesis route, and composition with phase formation, morphology, surface area, and antibacterial response against *Staphylococcus aureus*.

METHOD

Experimental concept

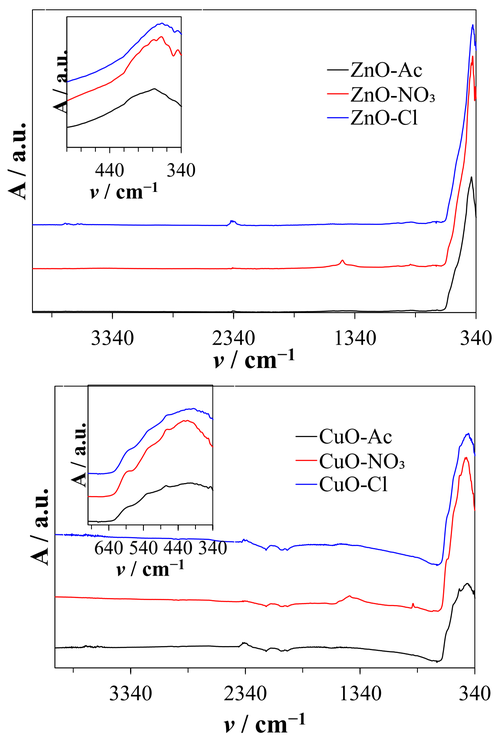
Synthesis: monometal-oxide nanoparticles and mixed Cu-Zn-Y oxide system with Zn:Cu:Y = 1:1:1.
Precursors: acetate (Ac), nitrate, and chloride salts. Tannic acid used as a stabilising / structure-directing agent.
Thermal treatment: calcination at 400 °C and 600 °C.
Characterisation: FTIR, PXRD, TG/DSC, SEM/EDS, and BET.
Biological test: viable *S. aureus* cells after 24 h exposure to selected nanoparticle concentrations.

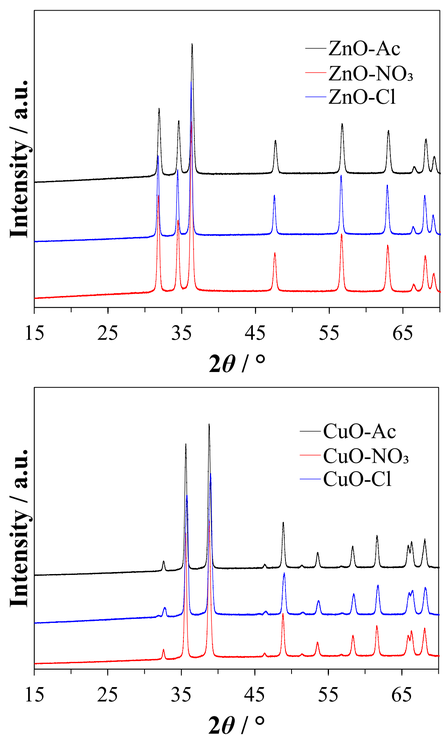
Ac / NO_3 / Cl precursors → **controlled synthesis** → **calcination 400-600 °C**

RESULTS & DISCUSSION

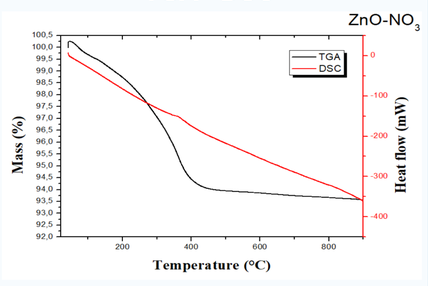
precursor anion & mixing route → **phase & bonding FTIR / PXRD** → **morphology & BET SEM / EDS / surface area** → ***S. aureus* response**

FTIR + PXRD comparison

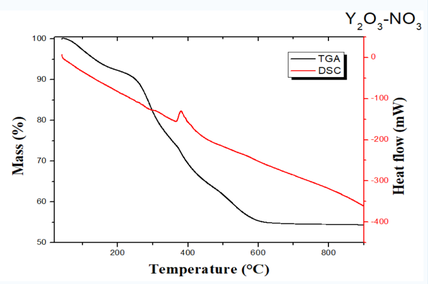




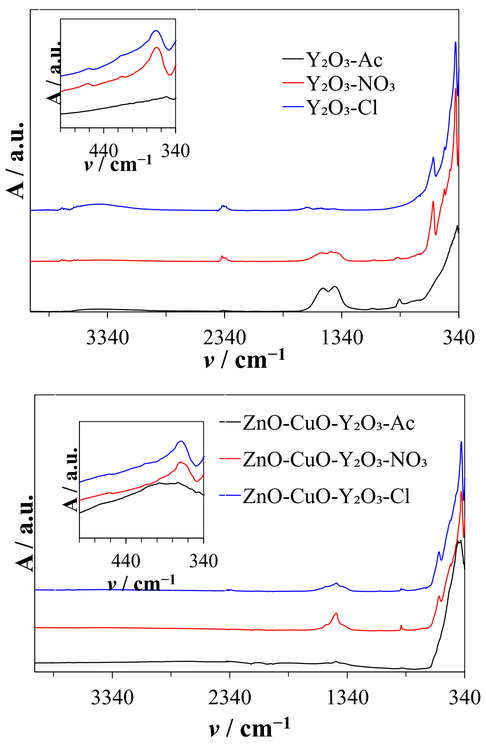
TGA - DSC

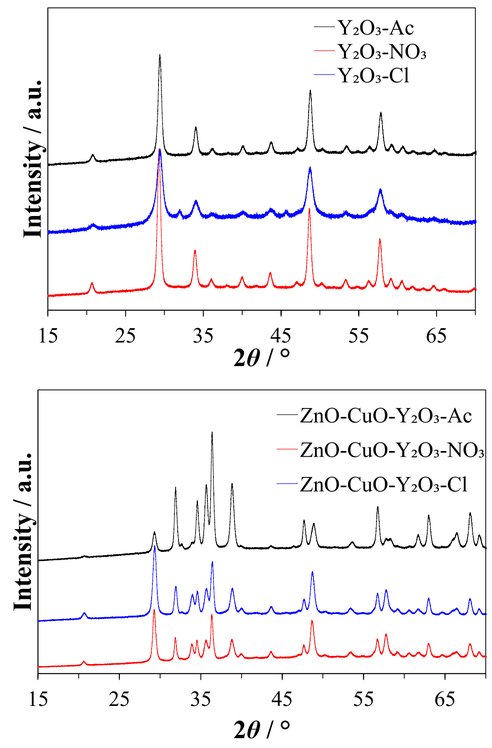


ZnO and CuO minimum calcination temperature of 400 °C

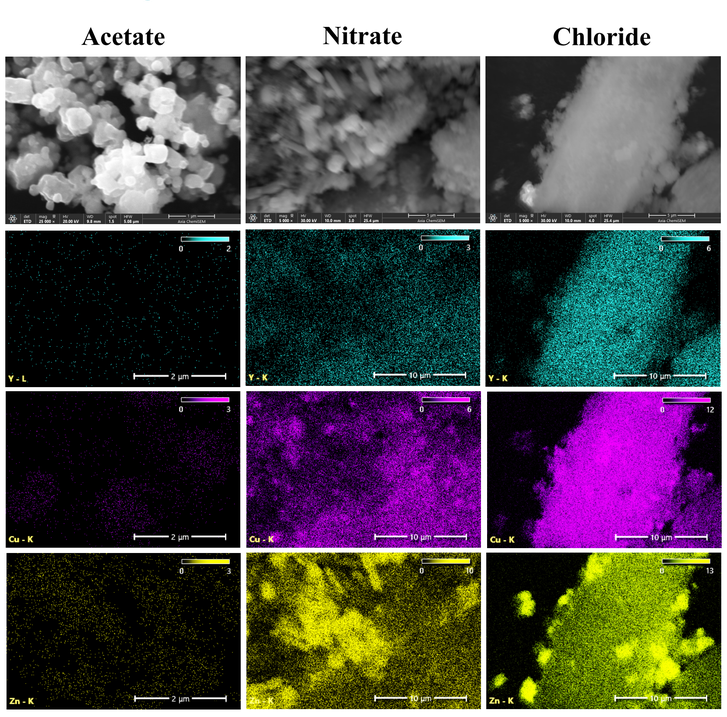


Y_2O_3 minimum calcination temperature of 600 °C

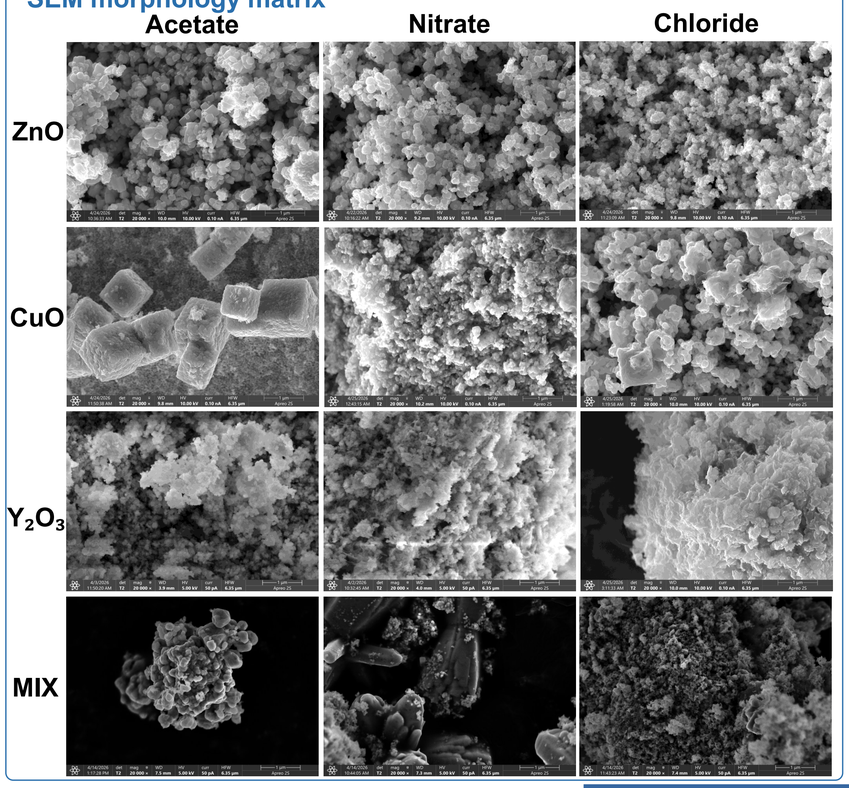




EDS mapping - mixed oxides

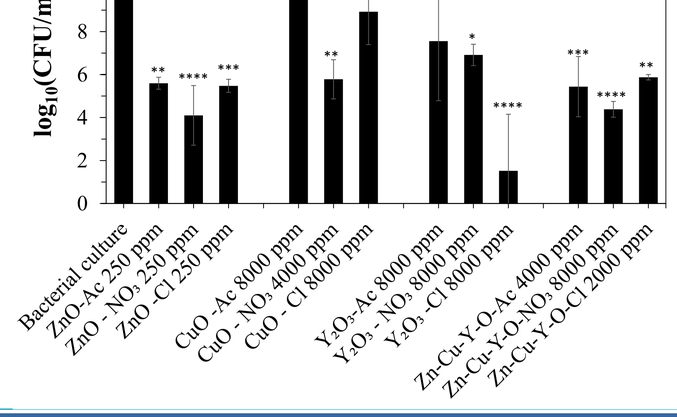


SEM morphology matrix



BET surface area table and Antibacterial activity

	BET / m^2g^{-1}			
	ZnO	CuO	Y_2O_3	Mix
Acetate	3.6459 ± 0.0489	1.4466 ± 0.0883	18.9133 ± 0.2041	2.7712 ± 0.0731
Nitrate	**4.2189 ± 0.0205**	**4.6676 ± 0.1241**	26.4594 ± 0.6254	8.2128 ± 0.0836
Chloride	4.4556 ± 0.1432	4.4671 ± 0.1278	**49.1900 ± 0.2730**	**9.1870 ± 0.0887**



CONCLUSIONS

ZnO nanoparticles showed the most efficient antibacterial activity against *S. aureus*, producing a significant reduction in viable cells already at 250 ppm.
The nitrate-derived ZnO and CuO samples exhibited the strongest effect, while the chloride-derived Y_2O_3 and mixed samples exhibited the strongest effect, indicating that the precursor type strongly influences antibacterial performance.
Compared with CuO, Y_2O_3, and mixed Zn–Cu–Y oxide systems, ZnO achieved the highest antibacterial efficiency at considerably lower concentration.
ZnO-based nanoparticles, therefore, represent promising candidates for antimicrobial surface-coating applications.

FUTURE WORK/ REFERENCES/ACKNOWLEDGMENT

References
1 .Matijaković Mlinarić, N. et al. , ACS Appl. Nano Mater. 7, 12550–12563 (2024).
2. Matijaković Mlinarić, N. et al. Nanomaterials 14, 570 (2024).

Future work aims to develop multifunctional coatings with nanoparticles for medical implants and wound dressings, integrating tailored antimicrobial and bioactive properties.