FROM "NANOIONS" TO MIXED-CHARGED NANOPARTICLES AND GRAM-SELECTIVE ANTIBIOTICS

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Nanoscopic objects stabilized with charged organics exhibit properties fundamentally different from either molecular or macromoleculer ions, and can combine ionic-like properties with electronic and ionic conductivity and/or photoexcitability. By careful control of electrostatic interactions, "nanoions" of various shapes and material compositions can be assembled into functional nanomaterials including 3D supracrystals, "layered" crystals, or extended films that can function as as chemical amplifiers, photoconductors, diodes, transistors, or even full-fledged electronic circuits containing no semiconductors. While these are exciting applications we have been developing for almost a decade now, our laboratory has recently extended the scope of „nanoionics" to particles covered simultaneously with two types of charged ligands of oppotite polarities. These [+/–] or mixed-charge NPs show unprecedented form antimicrobial activity against various bacterial strains with whose walls they interact via polyvalent electrostatic interactions. Remarkably, while nanoparticles covered with either [+] or [–] ligands alone are not effective antibiotics, NPs bearing an optimal ratio of the two ligands within a mixed [+/–] monolayer become potent antibacterial agents causing dramatic rupture of the bacterial wall. Remarkably, this optimal ratio is different for Gram-positive and Gram-negative bacteria meaning that the specificity of the [+/–] NPs can controlled by their surface compositions – this, to the best of our knowledge, is the first instance where the engineering of surface properties of nanoparticles translates into Gram specificity. The mixed-charge MC are non-toxic towards mammalian cells and in mice heralding the rise of a fundamentally new class of potent and selective antibiotics.

Key References:

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