Nanoparticle reactivity: a knife with two blades: from their health and safety risk to their use for indoor air microbiological remediation

Miguel A. Bañares[1], A. Serrano-Lotina[1], A. Vazquez-Calvo[2], P. Llanos[1], A. Gomez-López[1], R. Martin[2], V. Alcolea-Rodriguez[1], A. Alcamí[2]

[1] Spectroscopy and Industrial Catalysis, Instituto de Catálisis y Petroleoquímica, CSIC-ICP, Marie Curie 2, E-28049-Madrid, Spain
miguel.banares@csic.es

Lower respiratory tract infections represent the third leading cause of death in the world. Airborne transmission is the main propagation vector [1]. Virus-containing aerosols linger in air and remain infectious for hours. Current air virus inactivation methods are based on physical filtration, heat treatment, physical damage by UV-light or chemical damage by generation of reactive ions [2]. Their main problems relate to their efficacy, expensive materials, risk of infection during filter replacement, ocular and cutaneous UV-damage and the possibility of generating harmful secondary compounds. Our project develops catalytic filters, which will be placed in indoor air-cleaning device, inactivating viruses by oxidative stress through selectively heating the filter at mild temperatures.

Our experience in h2020 NanoInformaTIX project aiming at understanding the reactive bases of nanoparticle toxicity allowed us to predict environmental health and safety of nanomaterials [3], understanding nanomaterials reactivity. Among these, we have developed acellular oxidative stress assays to correlate with adverse outcome effect. Based on oxidative damage, such a knowledge can in turn be used to remediate indoor virus and bacteria by catalytic filters. To facilitate pre-screening, our acellular assay has been adapted and developed to evaluate the oxidative potential catalytic systems; it uses probe organic reactions. Acellular test are benchamarked vs. virus inactivation by plaque assays using virus in solution as first approach for inactivating power determination. Human coronavirus (HCoV-229E), severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and rhinovirus (HRV-14).

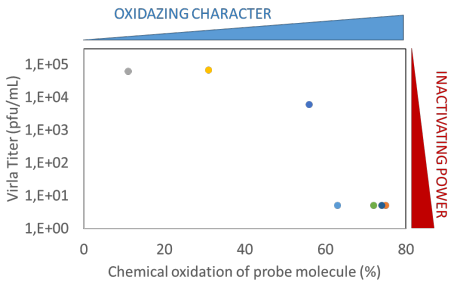

Figure 1: Correlation between the catalyst oxidizing character and virus inactivation power.

The oxidative potential of different filters was evaluated and correlated with its potential to inactivate HCoV-229E virus at 37 °C and 1 h (Figure 1). The figure illustrates how the acellular assay can be used for a preliminary screening of catalytic materials.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 814426 (NanoInformaTIX), CSIC PTI+ Salud Global Nextgeneration EU and CaixaFoundation HR22-00813 grant.

References

[1] Milton, D.K.. *Journal of the Pediatr Inf Dis Soc*, 9 (2020) 413
[2] Song et al., *J Hazard Mater*. 424(B) (2022) 127429
[3] https://www.nanoinformatix.eu/