Towards a new generation of antiviral tools. Hyperbranched polylysine nanopolimers and photoactive carbon dots as effective antivirals

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The coronavirus pandemic (COVID-19) has shown that different approaches must be put in place to confront viral infections. There is strong need for treatment options and a strong request for other effective, safe, and broad-spectrum antiviral systems in light of future emergent pandemics. In our laboratory we have developed two different nanotools as innovative antivirals based on carbon dots. The first example is a polymeric nanomaterial derived from L-lysine, with an antiviral activity against SARS-CoV-2 associated with a good safety profile in vitro. Nanoparticles of hyperbranched polylysine, synthesized by L-lysine thermal polymerization and catalyzed by boric acid, effectively inhibit the SARS-CoV-2 replication. The virucidal activity is associated with the charge and dimension of the nanomaterial, favouring the electrostatic interaction with the viral surface being only slightly larger than the virion dimensions.

Carbon dots (C-dots) are a type of nanomaterial that can produce reactive oxygen species (ROS) when photoactivated. These ROS can disrupt the structure of viruses, making C-dots a promising candidate for biocidal applications. Additionally, C-dots exhibit oxidant-antioxidant properties that can be used for antibacterial, wound healing, and antiviral purposes. Pro-oxidant C-dots have been developed via microwave synthesis using an amino acid, glycine, and 1,5-diaminonaphtaleneas precursors. The C-dots shown to contain radical centers whose intensity increases upon illumination by UV and also visible light. They also show the capability of generating singlet oxygen through energy transfer to oxygen molecules when irradiated. The C-dots exhibit effective virucidal activity and have been tested in vitro using two different variants of SARS-CoV-2. Antiviral C-dots have been finally used to functionalize a model surface, inducing a strong virucidal activity against the SARS-CoV-2 coronavirus with both ultraviolet (UV) and visible (VL) light. Controlled activation of C-dots can produce ROS on demand, ensuring their safe and effective use. With the development of photoactivated C-dots, effective disinfectants for enveloped viruses and antiviral surfaces are expected to emerge.

References

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Figures

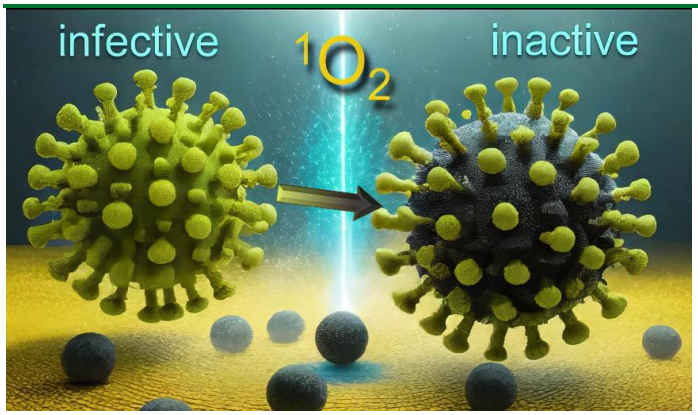

Figure 1: Singlet oxygen produced by C-dots is able to inactivate SARS-CoV-2 virions