Photodynamic treatment of titanium dioxide nanoparticles is a convenient method of viral inactivation

Zahorodnia S.D.[1], Povnitsa O.Y.[1], Artiukh L.O.[1], Zahornyi M.M.[2], Ievtushenko A.I.[2]

[1]D. K. Zabolotny Institute of Microbiology and Virology of the NAS of Ukraine, E-mail: zagorodnya.sveta@gmail.com

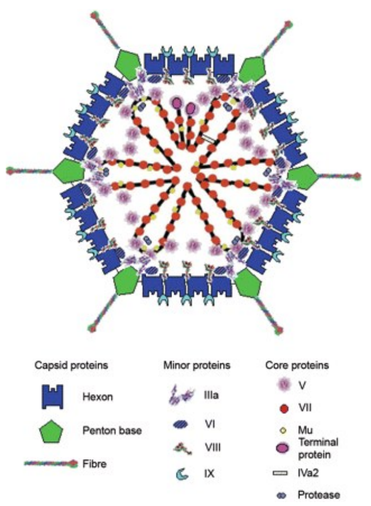
[2]I. M. Frantsevich Institute for Problems of Materials Science, NAS of Ukraine, E-mail: earsen@ukr.net

Introduction: The search for safe substances and methods of pathogen inactivation is one of the priority areas of research in the world. It is known that under the action of UV radiation, titanium dioxide (nano-TiO2) produces active oxygen-containing radicals capable of damaging biological molecules of pathogens, such as proteins, lipids, and nucleic acids. Titanium dioxide is widely used due to its unique properties. It is inexpensive, environmentally friendly and widely available in nature. The photocatalytic properties of TiO2 are used to destroy pathogenic bacteria, fungi, and algae in water and air environments. Photodynamic inactivation is used to inactivate super enveloped viruses such as human herpes simplex virus, vesicular stomatitis virus, human immunodeficiency virus and hepatitis B and C viruses.

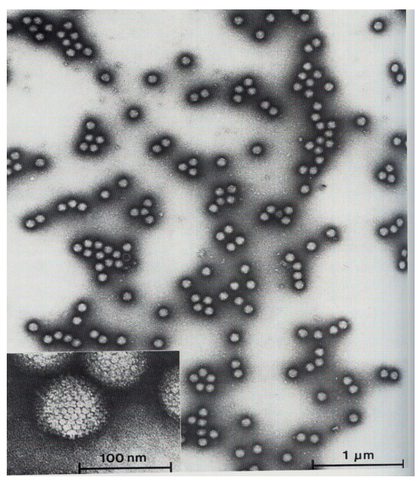
Tasks: Evaluate the possibility of using photodynamic ultraviolet treatment of synthesized TiO2 nanoparticles (NPs) to inactivate human adenovirus type 5 (HAdV5).

Methodology: The toxicity of NPs was evaluated using changes in cell viability and metabolic activity. The antiviral (virucidal) activity against HAdV5 and was assessed using MTT assay.

Results: The synthesis of nanopowders of titanium dioxide of anatase modification is developed. Synthesis of anatase-modified titanium dioxide nanopowders was developed. The properties of the obtained structures were studied and characterized. It was established that due to the mesoporous and crystalline structure, the modification of anatase TiO2 has photocatalytic activity.

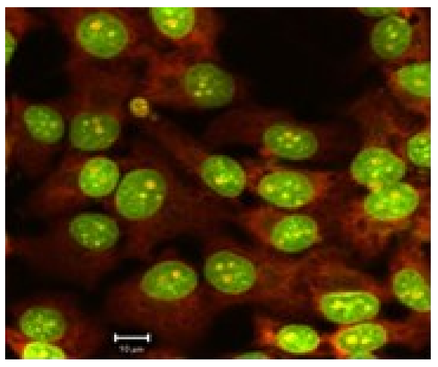


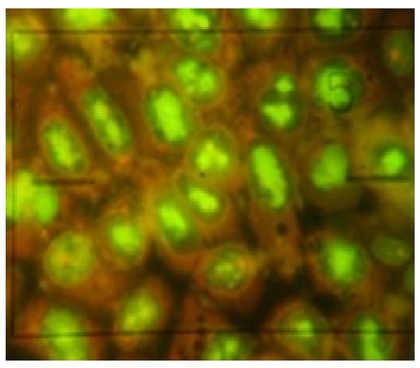
Structural model of adenovirus



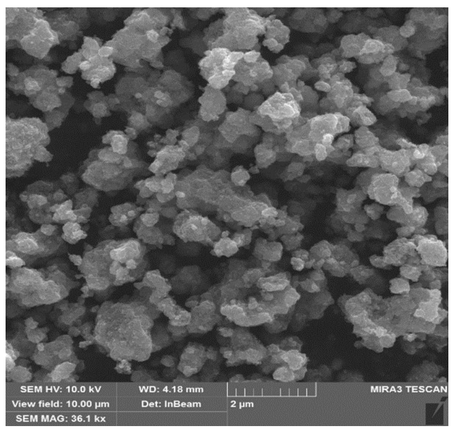
Electron microscopy of purified adenovirus

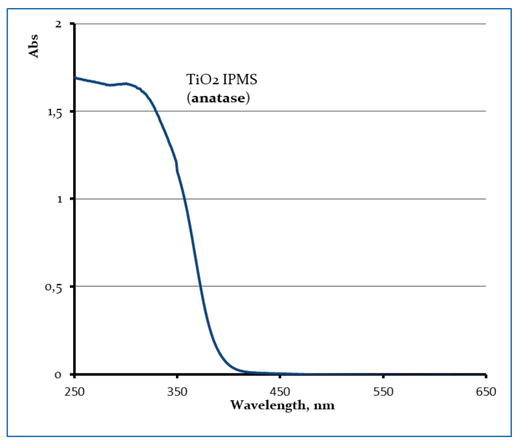
The suspension of TiO_2 in propanediol - alcohol (10 mg/ml) was irradiated with UV light (BactoSfera OBB15P, Ukraine) at a distance of 20 cm, a wavelength at the peak 254 nm, power 15 W, for 0, 5, 10, 20 and 30 minutes. Virus-containing material with a titer of 5.0 $\log_{10}$ $TCID_{50}$ / ml was added to the nanoparticles, a series of 10-fold dilutions was prepared, and Hep-2 cells were infected. After 3-4 days of cultivation using MTT analysis, virus titers were determined.





Uninfected and adenovirus-infected Hep-2 cells.

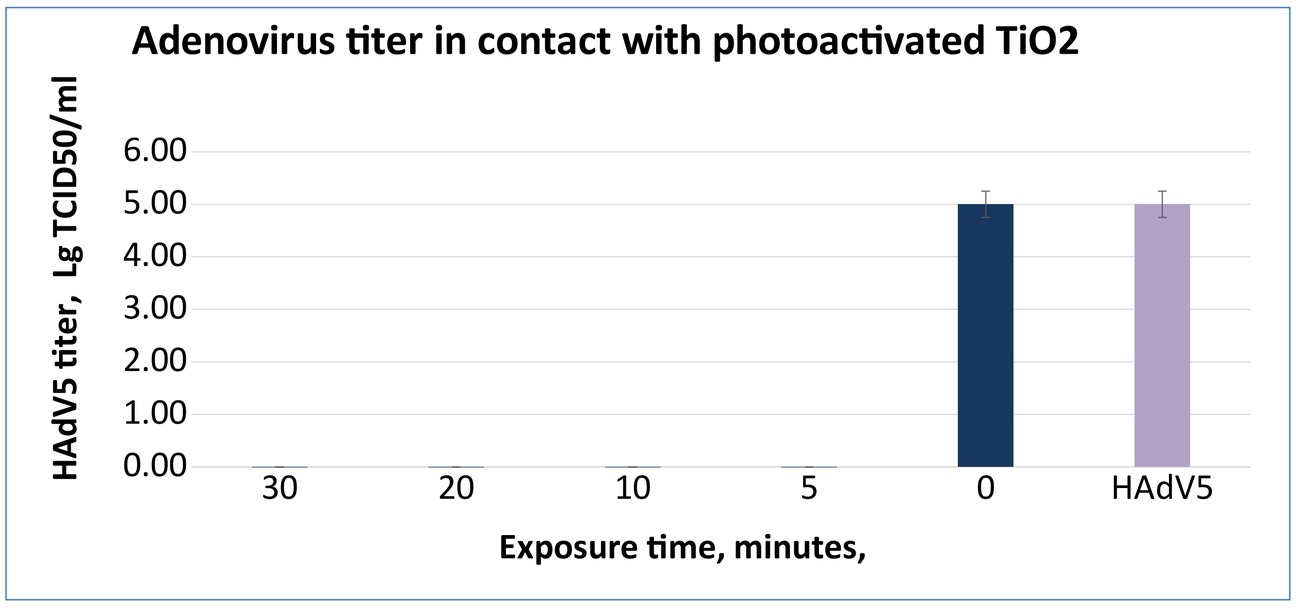




SEM TiO2 nanoparticles and optical absorbance of TiO2 nanoparticles. Synthesis of TiO2 were carried out by Tyschenko N.I., Lobunets T.F. (IPMS) dep.48.

Photocatalysis of TiO2 was studied by decomposition of methylene orange dye (MO). Previously, the ability of nano-TiO2 to undergo oxidative destruction was shown, in particular MO for anodic photoelectrocatalytic oxidation [Zahornyi M., Sokolsky G. Nanosized Titania Composites for Reinforcement of Photocatalysis and Photoelectrocatalysis//Academic Cambridge Scholars Publishing.-2022, P. 275 (ISBN: 978-1-5275-7786-4].

The antiviral effect of photoactivated TiO2 nanoparticles was studied. Adenoviruses do not contain super envelopes and are quite resistant to UV light.



Conclusion:.

We have shown that the non-enveloped virus HadV5 can be effectively inactivated by photoactivated titanium dioxide.

E-mail for discussion: Povnitsa@ukr.net Olga Povnitsa