PL-1.5

Tetrapods and Aeromaterials for Antiviral and Antibacterial Treatment and Therapy

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This talk will give an overview of recent advances in the field of antiviral and antibacterial treatments either for personal therapy or in air filtration systems from the functional nanomaterials group at Kiel University. In contrast to molecular drugs or similar medical agents, the main effect here is on the physical interaction or interaction with a nanostructured surface and not on a chemical effect influenced, for example, by the solubility of a drug. The entire system, i.e. in the case of a technical system its entire environment or in the case of personal therapy not only the disease, but also the surrounding network such as the immune system is exploited. Two main examples are followed: Tetrapodal microcrystals of zinc oxide and the graphene-based aeromaterials created from them by a templating process. While the pharmaceutical effects of zinc oxide nanoparticles, which are simply based on an excess of nanoparticles, have been widely used for a long time in various products such as creams and ointments due to their weak antiseptic and drying effect, e.g. to support the healing of herpes blisters, tetrapodal zinc oxide, which actually showed a curative effect based on an immunization only in 2016 [1] in animal models, has only recently been translated from the research group into the pharmaceutical market (see figure 1). For this purpose, the tetrapodal zinc oxide enables the immune system to detect the virus at an early stage via the CD4 CD 8 signaling pathway with the help of antigen presenting cells, which can easily internalize the virus enabled by an immobilization on specially adjusted nanoscale surface structures on the zinc oxide crystal. Besides the first product experiences of "Afinovir", a creme that contains GMP certified tetrapodal zinc oxide in herpes therapy, further antibacterial effects are now in focus. These might be utilized in 3D printed skin patches y their specific antibacterial effects and their ability to deliver proteins, like the VEGF for wound healing assistance, as shown by Leonard Siebert [2].

Compared to the effects in personal therapeutic medicine, the effects of sterilization provided by the Aeromaterials in air filtration systems are much less sophisticated. The combination of the structural features of Aeromaterials, the interconnected large free volume and the low weight are employed for a pyrolysis [3] of pathogens. Low mass means low heat capacity, which results in reaching high temperatures with relative low power. High free volume in connection with a hierarchical micro nanostructure means high filter efficiency. However, the example given in the framework of the Graphene Spearhead Project AEROGrAFT, a passenger jet air filter system is developed together with the aviation company Lufthansa Technik. It will be shown and discussed that beside technological obstacles the aviation certification procedure provides a similar challenge.

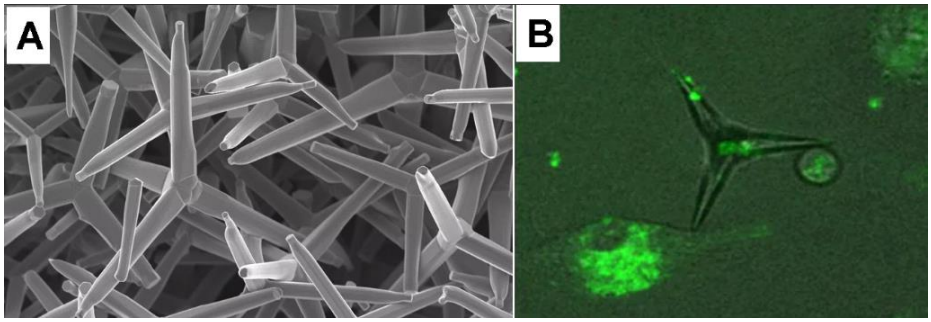

Fig. 1. Micrographs of tetrapodal Zink Oxide. A. Scanning electron microscopy image, the arm diameters of the ZnO microcrystals are in the order of ~1-3µm SEM. B. Fluorescence microscopy of a tetrapod with GFP labeled herpes virus bound to a tetrapod

References

1. The Journal of Immunology 196 (11), 4566-4575 (2016)
2. Advanced Functional Materials 31 (22), 2170154 (2021)
3. Materials Today 48, 7-17 (2021)