Environmental contamination by colloidal nanoparticles via vapors and water

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During the last decade, biomedical research has been identified as one of the fields that can greatly benefit from the advancement in nanotechnologies. In particular, the use of various kinds of nanoparticles (for example: metallic, metal oxides, semiconductors, silica, etc.) in biotechnology merges successfully the fields of material science and biology [1-3]. Although the potential of nanoscale objects in biology and medicine is really tremendous, a lot of questions remain about the safety of nanomaterials and the risk/benefit ratio of their usage. Thus, a whole field called nanotoxicology has emerged. It refers to the study of the potential negative impacts of the interactions between nanomaterials and biological objects. In almost absolute majority of cases, nanoparticles (NPs) dispersed in liquid solutions are manipulated and studied from cytotoxicity point of view. However, in several number of pulmonary toxicity studies, for example, various NP aerosols were used. Indeed, specific aero-dynamical characteristics of nanoparticles allow them, in particular, to be efficiently dispersed in gas phase.

We'll show that even if the NPs were initially dispersed in liquids they can be nevertheless easily auto-transferred into the surrounding air environment at relatively long distances during the natural evaporation of the liquids at room temperature. Such a natural transfer of the originally colloidal NPs into an aerosol state can easily lead to strong contamination of any biological system even if it is separated from the colloidal source of NPs by a gas phase space. We'll also report on an efficient transport of the colloidal NPs inside the vegetables through their root network.

To perform theses important illustrations, highly luminescent silicon carbide (SiC) NPs with cubic symmetry (3C) already successfully explored as fluorescent agents for living cell imaging [4] and therapeutic agents for preferential cancer cell killing [5] were used. The majority of our NPs have dimensions below 5 nm with the most probable size value being around 2.5 nm. Fresh thin onion epidermis and fibroblast animal cells (3T3) were used in our work as model bio-systems. The cells were exposed to the evaporating colloidal solutions at different distances in an open and confined airs. In another kind of experiments, onions were planted in water contaminated with the SiC NPs.

Typical fluorescence images of the onion epidermal cells exposed to the evaporating solutions without and with the SiC NPs are shown in Figures 1-a and 1-b, respectively. As one can see, no fluorescence is visible in the first case, while the cell structure of the fluorescent onion epidermis having large, well compacted, rectangular-like cells can be easily recognized in the second case. The similar results were obtained on animal fibroblast cells grown in DMEM solutions. Figure 2 illustrates dependence of the integrated luminosity per one cell on the vertical distance between the cell holder and the solution surface. In general, the higher the holder position is, the weaker the cell fluorescence intensity is, because the number of the NPs achieving the onion peels decreases drastically with the holder height. In addition, the curve behavior is strongly non-linear both for open and for confined air. However, the cell luminosity is generally higher in the case of the confined air in all range of the height values. Moreover, the smaller the NPs are, the higher the space is, that they can rich.

In conclusions, our presentation will illustrate the remarkable efficiency of the NP propagation in air and in living vegetables from aqueous colloidal solutions. Our results are very important for general understanding of the NP ability to contaminate air, water and food.

References

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Figures

Figure_1

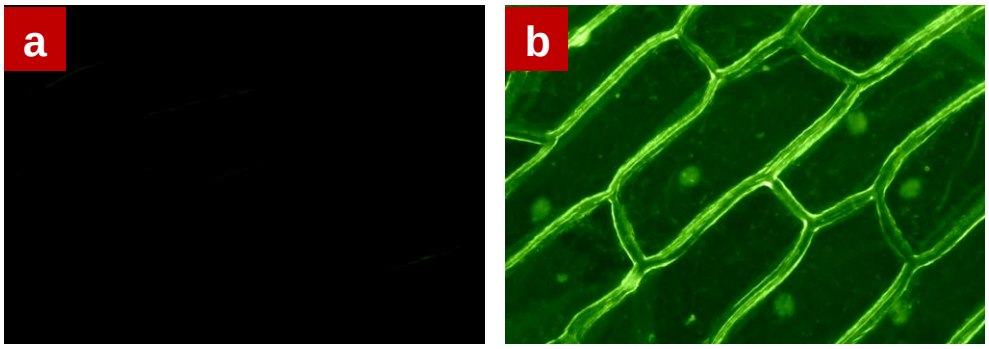

Figure_2

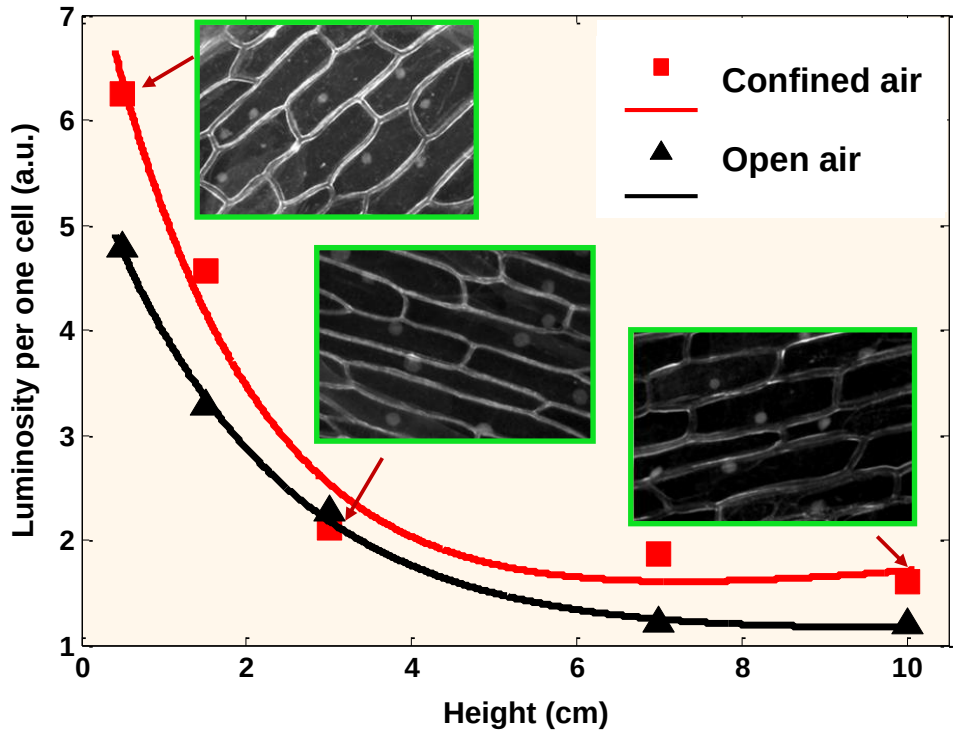

Figure captions:

Figure_1: Fluorescence microscopy images of onion epidermal cells exposed to the evaporating water solutions without (a) and with (b) the SiC NPs.

Figure_2: Dependence of the integrated luminosity per one cell on the vertical distance between the cell holder and the solution surface in open and confined airs.