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Optical periodical structures for decontamination of translucent microfluids

Ion N Mihailescu[4], Nicolae Enaki[1], Aurelia Profir[1,2], Nellu Ciobanu[1,3], Sergiu Bazgan[1], Andrei Nistreanu[1], Marina Turcan[1], Elena Starodub[1], Tatiana Paslari[1], Carmen Ristoscu[4] and **Maria Badiceanu[4,5]**

[1]Institute of Applied Physics Academy of Sciences of Moldova, Republic of Moldova
[2]Moldova State University, Republic of Moldova
[3]State University of Medicine and Pharmacy "Nicolae Testemitanu", Republic of Moldova
[4]National Institute for Lasers, Plasma and Radiation Physics (INFLPR), Romania
[5]University of Bucharest, Romania

Metamaterials with periodical structures like quartz or glass small granules irradiated by UV-C to act against microbial contamination of translucent liquids and gases are studied. Investigations of the modifications of individual metamaterial elements when UV evanescent waves are dispersed in the optical contact zone, as a function of granule geometry, were performed. Different situations were investigated, when quartz (SiO_2), glass, or black (plastic) materials with dimensions of about (0.5 – 3) mm are separately placed into a quartz tube of about 2.7 cm diameter and 90 cm length, named "core tube". Quartz granules transmit within the (240-400 nm) region of the Hg lamp and ensure an effective decontamination of translucent liquids and gases. Our approach is based upon the increased transfer of UV radiation via evanescent waves in case of unordered metamaterials present in contaminated fluids. We made a series of estimations of the decontamination rate of this type of metamaterials vs. ordered metamaterials consisting of spherical elements. Experiments have convincingly demonstrated that both quartz and glass metamaterials can effectively annihilate Coliform (including Escherichia coli) or Enterococcus bacteria, as well as yeast and Kombucha cultures. The decontamination efficiency was assessed both in dynamic and static treatment regimes. Control experiments were performed in the absence of metamaterials and/or UV-C irradiation.

ion.mihailescu@inflpr.ro m