Effect of nanostructured titanium dioxide on photoinduced cancer treatment

Nefeli Lagopati [1, 2], Evangelia A. Pavlatou [1], Athanassios Kotsinas [2], Vassilios Gorgoulis [2]

[1] National Technical University of Athens, School of Chemical Engineering, Laboratory of General Chemistry

[2] Molecular Carcinogenesis Group, Department of Histology and Embryology, School of Medicine, University of Athens

Abstract

The multivariate condition of cancer disease has been approached by scientific community in many ways. Recent studies focus on individualized treatments, minimizing the undesirable consequences of the conventional treatment methods. There are still aspects of the research field of alternative cancer treatments that remains to be discovered.

TiO_2 has a variety of applications of daily routine and of advanced technology. Due to its biocompatibility, it has also a great number of biomedical applications. It is well established that photo-excited TiO_2 nanoparticles, induce generation of pairs of electrons and holes which react with water and oxygen to yield reactive oxygen species (ROS) which can damage cancer cells. Therefore, TiO_2 is a promising photosensitizer against cancer.

The photo-excitement of TiO_2 can be achieved by UV light with significant anticancer effect, but the aim of this study is the development of TiO_2 nanoparticles with the potential to photo-induce anticancer effect via the mechanism of oxidative stress upon irradiation with visible light. Surface modification by doping with metal ions generally improves TiO_2 photocatalytic activity, as this process can lead to reduction of electron-hole recombination, resulting in efficient separation and stronger photocatalytic reactions. Particularly, silver is an important dopant, which up-regulates TiO_2 biological activity. Thus, Ag-doping of TiO_2 was undergone, followed by detailed characterization (XRD, micro-Raman, SEM). Cultured highly malignant, breast cancer epithelial cells (MDA-MB-468) were irradiated, using visible light, in the presence of Ag-doped TiO_2 aqueous dispersion. Cell viability was estimated, by MTT colorimetric assay. Western blot analysis of protein expression, as well as DNA laddering assay were employed to investigate the existence of cell apoptosis.

We demonstrated that Ag-doped TiO_2 nanoparticles induced apoptosis in cancer cells. The molecular mechanism of TiO_2 nanoparticles cytotoxicity is associated with increased pro-apoptotic Bax expression and caspase-mediated poly (adenosine diphosphate (ADP)-ribose) polymerase (PARP) activation thus resulting in DNA fragmentation and programmed cell death.

Further studies are already in progress, focalizing at the development of visible-light-excited co-doped TiO_2 nanoparticles with silver and nitrogen, for targeted cancer therapy in parallel with series of experiments, focusing on the encapsulation of TiO_2 in polymers, in order to control the release of nanoparticles for drug delivery system development.

References

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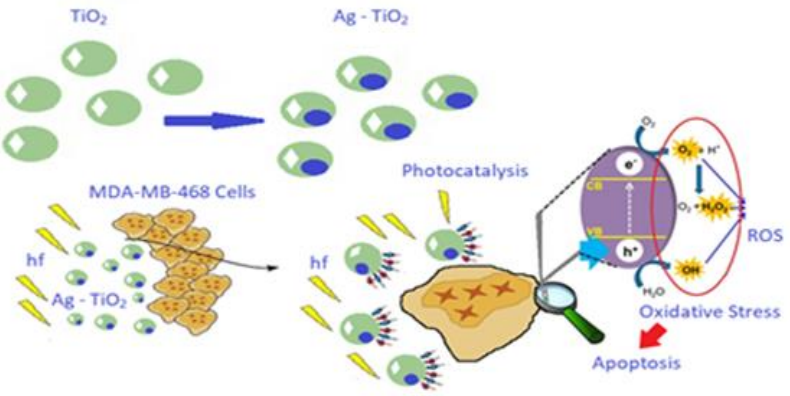

Figure. Schematic representation of photokilling effect of Ag-doped TiO_2 on breast cancer epithelial cells. Ag-doped TiO_2 nanoparticles induced apoptosis in highly malignant MDA-MB-468 cancer cells.