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Cytotoxicity of Titanium and Silicon Dioxide Nanoparticles

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Introduction

The toxicity of TiO_2 nanoparticles on different mammalian cell lines were investigated. The particles differ in their size, their BET-surface-area and their crystal structure. There was also a classification into fixed particles and into particles easily accessible in solution.
Nanoparticles can be incorporated into the human organism via skin, via the respiratory tract and via the elimentary system. Therefore, the particles were tested with fibroblasts (NIH-3T3), lung cells (A-549), liver cells (HEP-G2) and kidney cells (PC-12). The viability of the cells was determined by the MTT-test.

Materials and Methods

Cell culture

All cells were cultivated in an adequate culture medium in an incubator (37°C / 5 % CO_2).

Cultivation on TiO_2 coatings

Powders were suspended in the culture medium. Wells were coated with suspensions containing 0.1 % powders in the medium. The plates were seeded with a defined number of cells.

Cultivation in TiO_2 suspensions

Plates were seeded with a defined number of cells. The suspensions were added to the cells at a concentration of 0.1 % in the culture medium.

Cell metabolism

The viability of the cells was determined by the MTT-test.

Tested TiO_2 Particles

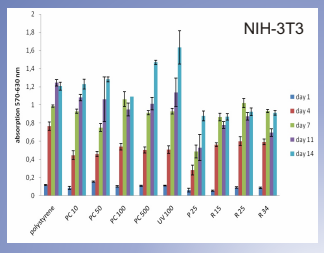
Powders	crystal structure	size of the nanoparticles (nm)	BET-surface area (m^2/g)
PC 10	100 % anatase	152	10
PC 50	100 % anatase	40	50
PC 100	100 % anatase	26	90
PC 500	100 % anatase	7	340
UV 100	100 % anatase	5-13	290
P 25	80 % anatase 20 % rutile	37 (anatase) 90 (rutile)	50
R 15	100 % rutile	20	65
R 25	100 % rutile	27	42
R 34	100 % rutile	36	33

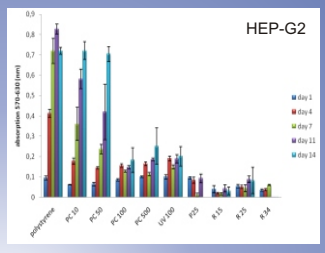
Tested SiO_2 Particles

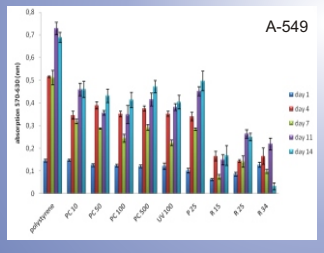
Particle	Elemental formular	structure
nano-Tetrapropylammonium-Silicalith-1 (TPA-MFI)	$[(C_{12}H_{28}NOH)_4[Si_{91}O_{192}]$-MFI	
nano-Tetramethylammonium-Gismondin (TMA-GIS)	$[(C_4H_{12}N)_8[Al_8Si_{12}O_{72}]$-GIS	
nano-Tetramethylammonium-Sodalith (TMA-SOD)	$[C_4H_{12}N]_2$ $[Al_2Si_{10}O_{24}]$-SOD	

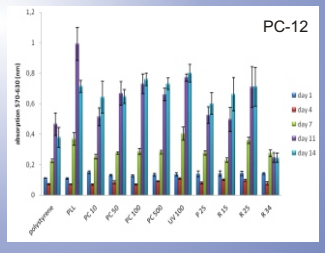
Results

Cultivation on TiO_2 coatings



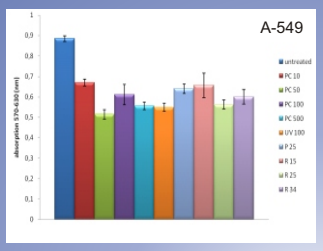


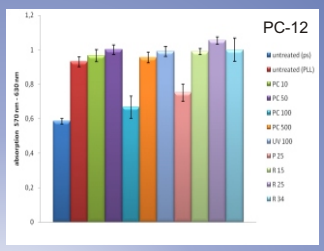




The figures show the viability of the cells cultivated on the different powder coatings over a period of 14 days. The average of 5 different adsorption measurements and the standard deviation are shown.

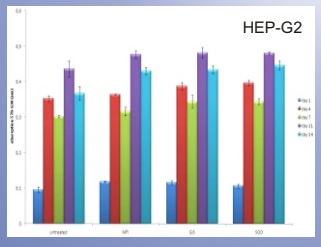
Cultivation in TiO_2 suspensions

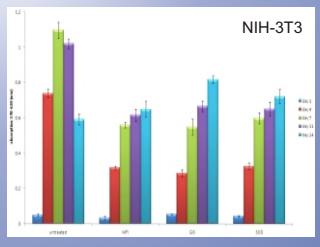




The figures show the viability of the cells cultivated in presence of TiO_2 suspensions in the culture medium.The average value of 5 different adsorption measurements and the standard deviation are shown.

Cultivation in SiO_2 suspensions





The figures show the viability of the cells cultivated in presence of SiO_2 suspensions in the culture medium. The average value of 5 adsorption measurements and the standard deviation are shown.

Conclusions

The adhesion of the cells on the different powders highly depends on the type of cell line and the type of powder. It was shown that the lower viability of some cells on the powders is not only caused by a cytotoxic effect of the powders, but also due to a lower adhesion of the cells on the surfaces. Furthermore, it was shown, that the physical properties of the powders do not correlate with any observed biological effect. The tested TiO_2 and SiO_2 nanoparticles exhibit no toxic effect on the cells.