May 20th, 12:30 PM

Multiple Approaches to Determine Toxicity of Micro and Nano-sized Titanium Dioxide Materials When Exposed to Human Red Blood Cells

Aaron Stella  
*University of Massachusetts Lowell*

Shu-Feng Hsieh  
*University of Massachusetts Lowell*

Dhimiter Bello  
*University of Massachusetts Lowell*

*See next page for additional authors*

Follow this and additional works at: [http://escholarship.umassmed.edu/cts_retreat](http://escholarship.umassmed.edu/cts_retreat)

Part of the [Biomedical Engineering and Bioengineering Commons](http://escholarship.umassmed.edu/bme), [Cell Biology Commons](http://escholarship.umassmed.edu/cellbio), [Chemistry Commons](http://escholarship.umassmed.edu/chem), [Nanomedicine Commons](http://escholarship.umassmed.edu/nanomedicine), [Nanoscience and Nanotechnology Commons](http://escholarship.umassmed.edu/nanotech), and the [Translational Medical Research Commons](http://escholarship.umassmed.edu/medtrans)

Stella, Aaron; Hsieh, Shu-Feng; Bello, Dhimiter; Schmidt, Daniel; and Rodgers, Eugene, "Multiple Approaches to Determine Toxicity of Micro and Nano-sized Titanium Dioxide Materials When Exposed to Human Red Blood Cells" (2014). *UMass Center for Clinical and Translational Science Research Retreat*. 117.

[http://escholarship.umassmed.edu/cts_retreat/2014/posters/117](http://escholarship.umassmed.edu/cts_retreat/2014/posters/117)

This material is brought to you by eScholarship@UMMS. It has been accepted for inclusion in UMass Center for Clinical and Translational Science Research Retreat by an authorized administrator of eScholarship@UMMS. For more information, please contact Lisa.Palmer@umassmed.edu.
Presenter Information
Aaron Stella, Shu-Feng Hsieh, Dhimiter Bello, Daniel Schmidt, and Eugene Rodgers

Comments
Abstract of poster presented at the 2014 UMass Center for Clinical and Translational Science Research Retreat, held on May 20, 2014 at the University of Massachusetts Medical School, Worcester, Mass.

Creative Commons License
This work is licensed under a Creative Commons Attribution-Noncommercial-Share Alike 3.0 License.

This is available at eScholarship@UMMS: http://escholarship.umassmed.edu/cts_retreat/2014/posters/117
Multiple Approaches to Determine Toxicity of Micro and Nano-sized Titanium Dioxide Materials when Exposed to Human Red Blood Cells

Aaron Stella1*, Shu-Feng Hsieh1,2, Dhimiter Bello2,3, Daniel Schmidt2,4, Eugene Rogers1,2

1Department of Clinical Laboratory and Nutritional Sciences, 2Center for High-rate Nanomanufacturing, 3Department of Work Environment, 4Department of Plastics Engineering, University of Massachusetts, Lowell, MA 01854

*contact author: Aaron_Stella@student.uml.edu

Abstract:

Introduction: The utility of engineered nanomaterials’ is growing, particularly the titanium dioxide (TiO2) polymorphs. TiO2 is very useful for brightening paints, and coloring foods. Nano-sized TiO2 is also useful for sunscreens, cosmetics, and can be utilized as a photocatalyst. However, the nanometer size and the large specific surface area of the TiO2 materials are physicochemical characteristics which may contribute to human red blood cell (RBC) damage. Using RBCs as a cellular model, we have evaluated the effects of TiO2 nanoparticle exposure to RBCs by quantifying oxidized glutathione, oxidized membrane vitamin E, hemolysis, hemoglobin adsorption, and cellular aggregation.

Results: Red blood cells are rich in the antioxidant glutathione (GSH). HPLC testing revealed that some TiO2 materials have the ability to cause oxidation of GSH to the oxidized form, glutathione disulfide (GSSG). Due to surface area characteristics, some TiO2 materials have the ability to adsorb protein (visualized as hemoglobin) to their surface. Additionally, some TiO2 materials microscopically form red blood cell aggregates, significantly changing the red cell morphology. The aggregation data was quantified using a hemacytometer. Red blood cell membrane vitamin E was also measured by HPLC, and after exposure to these TiO2 polymorphs, some materials caused vitamin E membrane oxidation. Some TiO2 materials have the ability, through multiple different mechanisms, to cause hemolysis of the red blood cell.

Conclusions: Our results indicated that some of the TiO2 polymorphs assayed contributed to red blood cell hemolysis via different mechanisms, whereas some polymorphs did not cause cellular damage. These data indicated that red blood cells can ultimately be hemolyzed by biological oxidative damage (BOD), intracellular oxidation of GSH to GSSG, oxidation of vitamin E in the RBC membrane, material adsorption to the RBC membrane, physical contact, or by a combination of these mechanisms.