

# A STUDY OF THE GRAPHENE OXIDE IMPACT ON VIRAL INFECTION RELATED TO A549 AND TC28A2 **HUMAN CELL LINES**



Piotr Kuropka<sup>1</sup>, Maciej Dobrzynski<sup>2</sup>, Barbara Bazanow<sup>3</sup>, Dominika Stygar<sup>4</sup>, Tomasz Gebarowski<sup>5</sup>, Anna Leskow<sup>6</sup>, Małgorzata Tarnowska<sup>6</sup>,

# Katarzyna Szyszka<sup>7</sup>, Malgorzata Malecka<sup>7</sup>, Nicole Nowak<sup>7</sup>, Wiesław Strek<sup>7</sup> and Rafal J. Wiglusz<sup>7</sup>

<sup>1</sup> Wroclaw University of Environmental and Life Sciences, Department of Biostructure and Animal Physiology, 25 Norwida St. 50-375 Wroclaw, Poland; <sup>2</sup> Department of Pediatric Dentistry and Preclinical Dentistry, Wroclaw Medical University, Krakowska 26 Street, 50-425 Wroclaw, Poland; <sup>3</sup> Department of Pathology, Wroclaw University of Environmental and Life Sciences, 50-375 Wroclaw, Poland; <sup>4</sup> Department of Physiology, School of Medicine in Zabrze, Medical University of Silesia, Katowice, Poland; <sup>5</sup> Department of Basic Medical Sciences, Wroclaw Medical University, Borowska 211, 50-560 Wroclaw, Poland; <sup>6</sup> Department of Nervous System Diseases, Faculty of Health Sciences, Wroclaw Medical University, Wroclaw, Poland; <sup>7</sup> Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Okolna 2, PL-50-422 Wroclaw, Poland

### **ABSTRACT**

Graphene is one of the most tested biomaterials since its discovery in 2004. It is known for its specific yet interesting properties, such as electrical conductivity, flexibility, antimicrobial action and high biocompatibility. In medicine, the antimicrobial, antiviral and antitumor properties of graphene are studied as intensively as its ability to transport drugs to pathological sites [1],[2].

[1] Geim, A.K.; Novoselov, K.S. The rise of graphene. In *Nanoscience and Technology*; Co-Published with Macmillan Publishers Ltd, UK, 2009; pp. 11–19. [2] Liu, J.; Cui, L.; Losic, D. Graphene and graphene oxide as new nanocarriers for drug delivery applications. Acta Biomater. 2013, 9, 9243–9257, doi:10.1016/j.actbio.2013.08.016.



**Image 1. SEM images of graphene oxide** 

2 theta (°)

#### MATERIALS AND METHODS

The protective effect of graphene oxide against rubella virus infection was investigated in models of human lung epithelial carcinoma cells line A549 and human chondrocytes line TC28a2. During the experiments, cells were incubated with graphene oxide alone and graphene oxide in combination with rubella virus. The cytopathic effect (CPE), which appears as the set of degenerative and pathological features occurring in the cells, which occurs due to viral replication, was measured in two incubation periods using the DAPI dye as a percentage of the altered cells.





Figure 2. Percentage of cytopathic effect in A549 cell line. RuV - cells infected with RuV, GO – cells with graphene added, GO+RuV – cells infected with RuV and with graphene added. p



Image 2. The A549 (ATCC-CCL-185TM) cell line 24 h after administration of virus and GO. A- control group, B- RuV group, C- GO group, D- RuV+GO group. Normal cells show regular, oval shape with nucleus present in the middle of the cells.



#### <0.05 - a when compared to control group; b when compared to RuV group.

Image 3. The A549 (ATCC-CCL-185TM) cell line 48 h after administration of virus and GO. A- control group, B- group RuV, C- GO group, D- GO+RuV group. Different ability of DAPI uptake (blue dots) by cells. In RuV 48 group visible arrangement of surviving cell in a colony manner.

B



Figure 3. Percentage of cytotopathic effect TC28a2 cell line. RuV - cells infected with RuV, GO – cells with graphene added, GO+RuV – cells infected with RuV and with graphene added. p <0.05 - a when compared to control group; b when compared to RuV group.



Image 4. The TC28a2 cell line 24 h after administration of virus and GO. A- Control group, B- RuV group, C- GO group, D- GO+RuV group. Mild cytopathic effect in cells with changed morphology (red arrow) after RuV administration is visible (red arrow).



Image 5. The TC28a2cell line. A - Group RuV, B- GO group, C- RuV group, D- GO+RuV group. Visible changes in cell morphology after administration of virus and graphene +virus. In TC28a2 (C and D picture) cell line after 48 hours after virus and graphene +virus administration increased cytopathic effect was noted.

## CONCLUSION

It was shown that graphene oxide alone did not show a cytopathic effect on any of the tested cell lines. Rubella virus itself is highly cytopathic to cells, but when combined with graphene oxide, the percentage of altered cells is much lower. It has been shown that graphene oxide has protective properties against infection of cells with rubella virus, limiting the frequency of cytopathic changes in human cells.



