ACTIVITY REPORT

NEW NANOCOMPOSITES BASED ON BIOCOMPATIBLE POLYMERS AND GRAPHENE FOR DENTAL APPLICATIONS - BIOGRAF (230/2014)

Project Coordinator

Dr. STELA MARIA PRUNEANU

Work package 2 (2015)

Preparation and optimization of nanocomposite synthesis. Development of the lab technology for nanocomposite synthesis.

A.2.1 Testing the reaction conditions for graphene preparation- Part II (CO-INCDTIM)

Graphene-oxide (GO) and its most encountered derivatives, thermally reduced graphene oxide (TRGO) and nitrogen-doped graphene (N–Gr), were chemically/thermally synthesized. After synthesis, they were morphologically and structurally characterized by various techniques, like TEM, UV-Vis, Raman and ^{13}C MAS solid state NMR.

A.2.2 Experimentation of lab technology for the preparation of new nanocomposites, used in dental restorations- Part II / A.2.8 Optimization of synthesis conditions (P1-UBB)

The lab technology for the preparation of nanocomposites with graphene oxide, used in dental restoration, was developed and optimized. In addition, the structural properties of selected nanocomposites were investigated and compared with those of commercial dental composite.

A. 2.3 Physico-chemical and mechanical characterization of nanocomposites (P1-UBB)

The absorption and the solubility of nanocomposites in water or artificial saliva were determined. Also, the translucency and the amount of residual monomer released in artificial saliva were obtained. The composite materials showed a different pattern of water absorption over time, depending on the type of dipping solution (water or artificial saliva). In terms of the amount of residual monomers, it was found that the nanocomposite with the highest percentage of graphene oxide had the highest value.

Act. 2.5 Experimental model -Part II (P3-Apel Laser SRL)

With the employed experimental set-up it was observed that the polymerization of the composite materials with graphene takes place under the 400-480 nm laser radiation. When higher wevalengths were used, such as 532 or 650 nm, no proper polymerization was achived, although the laser power was higher (without changing the laser spot). The polymerization reaction takes place in a short and narrow time interval (60-80 seconds).

Act. 2.4 In vitro biocompatibility studies of graphene samples –Part II (P2-UMF)

Several biological effects (cytotoxicity, oxidative stress induction, and cellular and mithocondrial membrane alterations) induced by GO, TRGO and N-Gr on human dental follicle stem cells were investigated. Graphene oxide (GO) shows the lowest cytotoxic effect, followed by the nitrogen-doped graphene (N-GR), while thermally reduced graphene oxide (TRGO) exhibits high cytotoxic effects. Graphene oxide induces oxidative stress without damaging the cell membrane. Nitrogen-doped graphene shows a slight antioxidant activity but at

high doses (20 and 40 g/ml) it penetrates through the cell membrane. Both graphene oxide and nitrogen-doped graphene are appropriate for usage in dental nanocomposites.

***Act. 2.9* Biological studies: in vitro assessment of apoptotic cell death (P2- UMF)**

Based on the data obtained from the cell viability test, we determined that the dental materials with graphene oxide (GO) were non-toxic to human dental follicle stem cells. Using FACS test, it was identified that the cells treated with the composites with GO had a high rate of living cells, which varied from 95.7 to 99.9%.

***Act. 2.6* Disemination of the research results to PhD students and PostDoc (CO; P1-UBB; P2- UMF)**

***Act. 2.7* Disemination of the research results (P3- Apel Laser SRL)**

The PhD students and PostDoc were actively involved in most of the research activities.

General Conclusions

All the activities foreseen within this work-package were accomplished:

- D4- Development of lab technology for the synthesis of nanocomposite with graphene (IT-12.2015);
- D5- Establishing the relationships between the nanocomposites structure and their behavior in the oral environment (IS-12.2015);
- ***3 ISI papers and 3 book-chapters were published***
- ***1 ISI paper was submitted for publication***
- ***4 papers were presented at International Conferences.***

ISI Papers:

1. F Pogacean, C Socaci, S Pruneanu, A R. Biris, M Coros, L Magerusan, G Katona, R Turcu, G Borodi, *Graphene based nanomaterials as chemical sensors for hydrogen peroxide – A comparison study of their intrinsic peroxidase catalytic behavior*, **Sensors and Actuators B 213 (2015) 474–483 *(FI 4.097)* (CO)**
2. D Olteanu, A Filip, C Socaci, A R Biris, X Filip, M Coros, M C Rosu, F Pogacean, C Alb, I Baldea, P Bolfa, and S Pruneanu, *Cytotoxicity assessment of graphene-based nanomaterials on human dental follicle stem cells,* **Colloids and Surfaces B: Biointerfaces 136 (2015) 791–798 *(FI 4.152)* (CO, P2)**

3. C Socaci, F Pogacean, A R. Biris, M Coros, M C Rosu, L Magerusan, G Katona and S Pruneanu, *Graphene oxide vs. reduced graphene oxide as carbon support in porphyrin peroxidase biomimetic nanomaterials* **Talanta, 148 (2016) 511-517** ***(FI 3.545)*** **(CO)**

4. M-C Rosu, C Socaci, V Floare-Avram, G Borodi, F Pogacean, M Coros, L Magerusan and S Pruneanu, *Photocatalytic performance of graphene/TiO_2-Ag composites on amaranth dye degradation*, trimisa la **Materials Chemistry and Physics- Nov. 2015 (CO)**

Book-chapters:

1. S Pruneanu, M Coroş and F Pogacean, *Bio-Functionalized Metallic Nanoparticles with Applications in Medicine*, Handbook of Nanoparticles, **Springer International Publishing, 2015, DOI 10.1007/978-3-319-13188-7_36-1, 1-13 (CO)**
2. C Sarosi, M Rosu, S Boboia, M Filip, C Alb, M Moldovan, *Efectul nanoparticulelor asupra cantității de monomer rezidual la nanocompozitele cu grafene*, **Editura Colorama, ISBN 978-606-93891-6-4, 2015, 88-93 (P1, CO, P2)**
3. L Silaghi-Dumitrescu, D Prodan, G Furtos, A Roman, V Prejmerean, M Moldovan, *Proprietati optice ale materialelor compozite*, **Editura Colorama, ISBN 978-606-93891-6-4, 2015, 143-151 (P1)**

International Conferences

1. M Coros, F Pogacean, M C Rosu, C Socaci, G Borodi, A R Biris, D N Becherescu Barbu and S Pruneanu, *Synthesis of graphene oxide by electrochemical exfoliation of graphite*- 10^{th} biennial International Conference on Processes in Isotopes and Molecules (PIM 2015), 23-25 septembrie 2015, Cluj-Napoca, Romania- poster **(CO, P3)**
2. C Sarosi, M Rosu, L Silaghi-Dumitrescu, V Prejmerean, M Moldovan, *Comparative translucency of graphene-silica experimental nanocomposites and esthetic composite materials*, SCAD 2015 Annual Conference, 24-26 septembrie 2015, Chicago, SUA- poster **(P1, CO)**
3. C Sarosi, S Pruneanu, S Boboia, M Filip, C Alb, M Moldovan, *The nanofiller effect on the residual monomers amount of the graphene dental nanocomposites*, Simpozion Napoca Biodent 2015, 27-28 martie 2015, Cluj-Napoca, Romania- poster **(P1, CO, P2)**
4. C Sarosi, M Rosu, S Boboia, M Filip, D Prodan, C Prejmerean, C Alb, M Moldovan, *The evaluation of water sorbtion/solubility and monomer release on graphene dental nanocomposites*, International Seminar on Biomaterials and Regenerative Medicine, 17-19 septembrie 2015, Oradea, Romania- poster **(P1, CO, P2)**