

FINAL REPORT
Contract no. 63 CB/2008

Title: „Shielding and absorbent panels for special purposes, based nano structured composites with predefined architecture and customised dielectric and EMC properties”

□EMROTUPAN–

Web page: www.emrotupan.ee.tuiasi.ro

Project duration 17 months

End Year: 2009

Romanian Partner: The “Gheorghe Asachi” Technical University from Iași

Head of Institution

Rector Prof. Ion Giurma, PhD. Eng

Project manager

Prof. Romeo Ciobanu, PhD. Eng.

Foreign Partner: Istanbul Technical University, Turkey

Head of Institution

Vice Rector

Prof. Dr. Mehmet Karaca

Project manager

Prof. A. Sezai Saraç, PhD

CONTEXT

Electromagnetic Interference (EMI) and Electromagnetic compatibility are becoming important issues in the design of novel high-speed transmission networks and producing safe and sure equipment, especially at base-sites, with fast growing market at more than 5-7 % per year.

Classical cellular solids used in shields / absorbers and Salisbury screen applications are either massive metallic or metal-multilayer structures with loss inclusions (mainly graphite), based on polymeric or aramid paper material. These material solutions do not offer enough degrees of freedom to the EM designer especially at GHz frequency domain, neither do they offer optimised configuration for the structural loading or thermal effects they have to bear.

On the other hand, insignificant research activity was dedicated up to date in the area of protective panels for locative, working, medical etc. spaces against high power EM emitters (e.g. GSM emitters placed on apartment blocks, radar stations in the vicinity of residential areas), or protection of people with smart implants and prostheses, protection of medical equipment, protection of patients against EM effects of medical investigation equipment, protection of workers under certain EM conditions, or for other safety purposes (to avoid reflections – radar, airport, vehicles, in telecommunication technology etc.).

There are a number of industrial fields and research areas where e.g. Romania is between leading countries, with internationally recognised contributions, and the situation is similar for Turkey. Such situation should be rationally exploited, and the project subject outlines one of the kind, related to composite structures technology and advanced applications.

The situation in Romania is dramatic, due to the privatisation and post-privatisation effects and new economical context after EC integration, as all SMEs should competitively orient themselves to new free market interests. More than that, the Romanian partner is coming from the NE region, the less developed one and with highest unemployment rate. Any technological deployment able to sustain the existing SMEs in the region, either metal or plastic processors, automotive or building companies etc. may represent a benefit for the region and country in all.

Turkey has a peculiarly important industry of plastics and additives and the project may represent a flexible way of diversifying the actual production towards high tech materials. The industry in all production chain from powders, polymers, additives, panels, finite products etc. may benefit from the new competitive applications of such structures. In a similar way, other important Turkish industries such as electronics or defence may clearly benefit.

GENERAL AIM OF THE PROJECT

The project promotes a novel concept of nano-conductive-polymer composites with predefined architecture and customised dielectric and EMC properties, to be widely used in many civil and defence domains. The project has assess and benchmark the overall EMC properties of the proposed composites against the ones of massive / multilayer systems currently used in sandwich structure applications, in order to provide important information about the overall engineering feasibility of the novel shielding / absorbent panel concept, and to identify costs and benefits on adopting such innovative structures.

SPECIFIC OBJECTIVES OF THE PROJECT

To achieve the intended purpose were established the following objectives:

- Design, simulation and manufacturing of nano-conductive polymer assemblies with predefined architectures;
- Design of EMC filter properties of nano-conductive-polymer composites for shielding and absorbers at up to GHz frequency domain;
- EMC testing of panels and multidomain structural design optimization (both mono-layer and sandwich) / complementary mechanical, acoustic, thermal & Environmental testing

RESOURCES

In this project were involved two renowned institutions, both with sensitive equal contributions to the objectives of research:

- “Gheorghe Asachi” Technical University from Iași, the main scientific responsible for shielding and absorbent panels for EMC applications – design, simulation and tests (Romanian partner);
- Istanbul Technical University, the main scientific responsible for nano-conductive composites design and properties (Turkish partner).

The research team who participated in the activities research was represented by 19 members (experts with experience in the field, professors, PhD students, master and research assistants) from which 10 members of the Romanian team and 9 of the Turkish team.

RESULTS

During the project were successfully fulfilled all the goals that research team has proposed for completion during the 17 months. Such research activities have resulted in:

- Manufacturing of nano-conductive-polymer composite thin films samples with different concentration of pyrrole, polypyrrole, n-metil-pyrrole, polyacrylonitrile;

- Dielectric properties of polymeric thin films;
- Electromagnetic simulation of nano-conductive polymer composites by integrating in related panels: Salisbury, Jaumann;
- Simulation of electromagnetic wave propagation. It was highlight the specific phenomena when passing through different environments showing the behavior dependence of the characteristics of material;
- Prototype samples of coatings of nano-conductive-polymer composites with predefined architecture and dedicated dielectric and EMC properties (up to GHz frequency domain);
- Optimisation of panel geometry and load properties for optimum reflection, absorption and/or transmission requirements, according to certain applications.

ACHIEVMENTS OF THE PROJECT

Training / work visits of Turkish partners in Romania

- Between 02 – 12.11.2008 Professor A. Sezai Sarac, the project manager of the Turkish partner visit the “Gheorghe Asachi” Technical University of Iași. During the visit were made measurements of dielectric properties for thin films of polymers and copolymers of carbazole. Between 8-11.10.2008 Prof. A. Sezai Sarac and Prof. Romeo Ciobanu visit The Transylvania University of Brasov.
- Between 24 - 28.11.2008 Professor Hale Karakas Istanbul visit the university from Iași, visit foreseen in the schedule of project implementation. New tests were conducted to determine the dielectric properties of new polymer film samples of polypyrrole.
- Between 07 – 14.11.2009 PhD students Kaya Nazif Uğur and Suat Cetiner visit the Technical University of Iasi.

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Training / work visits of Romanian partner in Turkey

- Between 06 - 20.10.2008 a team of 4 members of the research team planned a documentation visit at Technical University of Istanbul - Electropol Nanotech Research Group which has an extensive experience in chemical and electrochemical polymerization, conductive polymers and copolymers field and their characterization. Both teams in Turkey have been performed tests to determine methods for increasing electrical conductivity by using polymers with self-conductive electrons but also to obtain polymer nanocomposites.
- Between 05-19.08.2009 PhD Sebastian Arădoaei, member in the Romanian research team visit the Turkish partner. Were performed FTIR-ATR analyses of composites films with a reflectance spectrophotometer available in the laboratory of Technical University of Istanbul.

▪ In November Professor Romeo Ciobanu and Professor Cristina Schreiner professor were invited by Professor A. Sezai Sarac to a last meeting in this project. Have been dashed the results of this collaboration, the difficulties encountered in obtaining them but also finding common research directions for submission new proposals.

Workshops and scientific events

◆ Between 01 – 05.10.2008 was organized the "**Advanced Materials and Technologies from FP7 Bilateral Cooperation to Partnership**" workshop within 5-th International Conference on Electrical & Power Engineering- EPE 2008 held at Faculty of Electrical Engineering. Discussions had as main topics: ▪Electromagnetic shielding – high importance problem for society); ▪Nanotechnologies and nano-conductive composites; ▪ Advantages of shielding / absorbent panel; ▪Polymerization and synthesis of polymeric composite thin films; ▪Identification of potential appliances in defense, electric/electronic, medical industries, constructions, aeronautics and automotive industries.

We appreciate that by the extended participation, the scientific level achieved, the expected effects of short-term or perspective, the event is part of the list of successful scientific events.

◆ Between 08–09.11.2009 in collaboration with the Turkish partner was organized “**From bilateral towards international cooperation— Advanced polymer nano-structures**” **workshop** which was attended by participants from the country and abroad, specialists in electromagnetic shielding and advanced materials. Romanian partner of the project involved the entire research team and the Turkish partner was represented Suat Cetiner and Kaya Uğur Nazif.

The discussions had as main topics: ▪ essential tasks of the project, ▪problems encountered in solving these tasks, ▪integration of the project results in the related European research area ▪identifying target groups that can directly benefit the new materials proposed in the project, ▪increasing the Romanian research visibility, ▪proposals for new potential collaborations with specialists in advanced materials.

Have been presented papers like “Electromagnetic energy absorption and related heating effects in chiral based microwave shields – I. Dielectric behavior with application in energy harvesting”, „Electromagnetic energy absorption and related heating effects in chiral based microwave shields – II. Localized thermal effect on microwave energy dissipation”,

„Simulation of nano-conductive composites for electromagnetic shields”, „Etude du comportement dynamique de panneaux sandwichs a l’impact”.

It should be noted that the success of the workshops was due to the great organizational efforts, all participants being absolutely delighted with the conditions of the meetings, the location, accommodation, quality materials and discussed topics.

Articles

The results of the research activities of EMROTUPAN CB63/2008 project were communicated by the publication of three articles.

1. A. Sezai Sarac, S. Cetiner, F. Kalaoglu, H. Karakas, G. Bakkalci, R. Ciobanu “***FTIR Spectroscopic Studies On Polyacrylonitrile/ Polypyrrole Composite Thin Films***”, Advanced Composite Materials Engineering □COMAT 2008 – Braşov, Vol. I- A, pg. 283-288.
2. A. Sezai Sarac, R. Ciobanu “***Charge effect on the electrochemical impedance of Poly(2,2-diakyl-3,4-propylenedioxythiophene) coated carbon fibre electrode***”, Buletinul Institutului Politehnic Iaşi, Tomul LIV (LVIII), Fasc. 3, Electrotehnică, Energetică, Electronică 5-th International Conference On Electrical & Power Engineering – EPE 2008 Iasi.
3. S. Çetiner, H. Karakas, R. Ciobanu, M. Olariu, N.Ugur Kaya,C. Unsal, F. Kalaoglu, A. Sezai Sarac, “***Polymerization of Pyrrole Derivatives on Polyacrylonitrile Matrix, FTIR-ATR and Dielectric Characterization of Composite Thin Films***”, to be published in "Synthetic Metals" journal.

Training of young scientists at doctoral level

As an immediate application of the studies and measurements within the project the results were used for doctoral thesis entitled: "Contributions on quality assurance of micro and nanomaterials based electric space charge " developed by PhD Marius Olariu and sustained in March this year and "Research on the development of absorbing screens and panels based nano-structured composite with predefined architecture and electromagnetic properties up to GHz" developed by PhD. eng Ramona Burlacu to be sustained in July 2010.

Working group

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