How to prepare an explosion protection document

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Introduction

Over the recent years (since the first decree of the Minister of Economy, Labour and Social Policy of 29 May 2003 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres/*rozporządzenie Ministra Gospodarki, Pracy i Polityki Społecznej z dnia 29 maja 2003 r. w sprawie minimalnych wymagań dotyczących bezpieczeństwa i higieny pracy pracowników zatrudnionych na stanowiskach pracy, na których może wystąpić atmosfera wybuchowa/* [9] was set up and amended by the Minister of Economy in 2006 [10]), many publications have been covering a subject of an explosion protection document (being increasingly referred to as the EPD in short). However, many of these publications and conference papers, such as for example references [11, 12], duplicated the main requirements presented in the above mentioned legal acts. They indicated that, first of all, such a document should include descriptions of organisational and technical actions undertaken by an employer in order to achieve the following:

1. The prevention of the formation of the explosive atmospheres; and if this is unlikely, the aim of eliminating the ignition sources.
2. The application of measures to minimise the effects of an explosion in order to provide the safety and health protection of the workers.

In accordance with § 5. 1. of the above decree, "The employer is in possession of the explosion protection document and keeps it up to date on regular basis", and further:

2. The explosion protection document, hereinafter referred to as "the document" should include:

- The information on the identification of explosive atmospheres and an explosion risk assessment.
- The information on adequate measures taken against the explosion hazards elaborated in the form of a Table.
- The list of potentially explosive workplaces along with their classifications.
- The declaration that workplaces and work equipment, as well as protecting and warning devices are designed, operated and maintained with due regard for safety.

For that reason, the measures were predominantly limited to a more detailed analysis of the above requirements, while other recommendations spread at various places of the decree were neglected. Also little attention was paid to create a uniform specimen of the EPD or present (recommend) the methods of assessing the hazard and risk of explosion since the legislator did not formulate any recommendations or suggestions about this issue.

The European Commission imposed the necessity to amend the Polish law in the scope of the full implementation of the requirements of Directive 1999/92/EC [13]. As a consequence, the above mentioned legal acts were replaced by a new decree of the Minister of Economy of 8 July 2010 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres [14]. This legal act is much more expanded in comparison with the previous ones. It transfers all requirements of Directive 1999/92/EC into the Polish legal status. But it still does not specify many crucial executive elements – they were to be included in the guide entitled: "Non-binding Guide of Good Practice for implementing of the European Parliament and Council Directive 1999/92/EC on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres" elaborated by the European Commission DG for Employment, Social Affairs and Equal Opportunities in 2003 [15]. According to the authors of this paper, this guide is of poor quality and little usefulness in Polish conditions regarding the needs and expectations of industrial companies, particularly small and medium enterprises.

Guides for employers

Two guides dedicated to the employers from enterprises with workplaces of a potentially explosive atmosphere have been worked out under the research and development project No. 5.R.07 within the framework of the Multi-annual Programme "Improving safety and working conditions" [16] co-ordinated by the Central Institute for Labour Protection – National Research Institute in order to find a solution for this difficult situation. The first guide is entitled "How to work out an explosion protection document at the workplace"; and the second one "Technical guidelines. Methods of assessing the hazard and risk of an explosion and anti-explosion protection measures."

The layout of the first guide shows how to prepare the EPD step by step in conformity with the proposed framework of this document. Moreover, every point of this guide explains which piece of information and in what form should be placed in this document. The framework of this document standardizes its content and the sequence of providing technical and organisational information required by law. The requirements are placed at various places of this legal act. For ease of use, every point of the guide includes a reference mark corresponding to the section, paragraph or point of the decree of the Minister of Economy from 2010. [14].

This guide also contains such helpful annexes as: a glossary of used terms, a list of the EU and Polish legal acts being in force, a list of the most important PN-EN standards on the assessment of the explosion hazard and protection against it, form specimens, checklists, lists as well as statements and declarations of the employer. It is also richly illustrated with pictures and tables containing helpful data.

The proposed specimen of the EPD framework (Tab.1) is divided into 3 main parts:

Part. 1. General information (includes statements and deadlines related to the EPD).

Part 2 Detailed information (includes an assessment of the hazard and risk of explosion as well as ways of prevention and protection against the effects of an explosion), and

Part. 3 Information and supplementary documents (include reports, certificates, confirmations and procedures that can be only presented in the form of lists, without attaching them to the guide).

Table 1

The framework draft of the explosion protection document

THE SPECIMEN OF THE FRAMEWORK FOR THE EXPLOSION PROTECTION DOCUMENT.

PART 1
GENERAL INFORMATION

1. THE EMPLOYER'S STATEMENT THAT THE WORKPLACES, WORK EQUIPMENT, INCLUDING WARNING DEVICES, ARE DESIGNED, OPERATED AND MAINTAINED WITH DUE REGARD FOR SAFETY (§ 7.3 POINT 3a OF THE DECREE)
2. THE EMPLOYER'S STATEMENT THAT WORK EQUIPMENT CONFORMS TO THE PROVISIONS OF SEPARATE REGULATIONS ON MINIMUM REQUIREMENTS FOR THE SAFETY AND HEALTH PROTECTION REGARDING THE USE OF MACHINES BY THE WORKERS DURING NORMAL OPERATIONS (§ 7.3 POINT 3b OF THE DECREE)
3. THE EMPLOYER'S STATEMENT ON ASSESSING THE RISK OF POTENTIAL OCCURRENCE OF THE EXPLOSIVE ATMOSPHERE (§ 7.3 POINT 3c OF THE DECREE)
4. THE LIST OF POTENTIALLY EXPLOSIVE ATMOSPHERES AND THEIR CLASSIFICATION INTO ZONES ON THE BASIS OF THE LIKELIHOOD AND DURATION OF THE OCCURRENCE OF EXPLOSIVE ATMOSPHERES (§ 7.3 POINT 2 OF THE DECREE)
5. INFORMATION ON DEADLINES FOR REGULAR INSPECTIONS OF APPLIED PROTECTION MEASURES REFERRED TO IN PART 2 POINT 4 OF THIS DOCUMENT (§ 4.3. OF THE DECREE)
6. THE EMPLOYER'S STATEMENT ON ENSURING SAFETY AND ADEQUATE SUPERVISION OVER THEIR WORKERS AND CONCISE DESCRIPTION OF MEASURES THAT HAVE BEEN TAKEN IN ORDER TO FULFIL THE PROVISIONS OF THE DECREE AND TO LIMIT DETRIMENTAL EFFECTS OF THE EXPLOSION (§ 7.3 POINT 1, § 4.1 AND § 4.6 OF THE DECREE)

PART 2
DETAILED INFORMATION

1. THE ASSESSMENT OF EXPLOSION AND FIRE RISKS

1.1. IDENTIFICATION OF USED FLAMMABLE SUBSTANCES AND THEIR PHYSICAL AND CHEMICAL PROPERTIES
- 1.1.1. Basic physical properties.
- 1.1.2. Flammable properties.
- 1.1.3. Explosive properties in the mixture with air.
- 1.1.4. Other possible hazardous properties: toxic, detrimental, oxidising, and corrosive properties, etc.
- 1.1.5. The classification of used substances and mixtures according to the REACH regulation.

1.2. THE CONCISE DESCRIPTION OF THE PROCESS IN WHICH THE EXPLOSIVE ATMOSPHERE MAY OCCUR WITH USED FLAMMABLE SUBSTANCES

1.3. THE CONCISE DESCRIPTION OF THE WORKPLACE WHERE THE EXPLOSIVE ATMOSPHERE MAY OCCUR
- 1.3.1. The description of installations, apparatuses, and equipment.
- 1.3.2. The description of normal operations.
- 1.3.3. The description of installations, substances used, processes and their interaction.

2. THE DESCRIPTION OF THE EXPLOSION RISK

2.1. THE DEFINITION OF REPRESENTATIVE EXPOSURE SCENARIOS
- 2.1.1. Exposure scenario No. X.
- 2.1.1.1. Working people (own workers, subcontractors).
- 2.1.1.2. Consumers, visitors, students, apprentices, inspectors, etc.

3. THE ASSESSMENT OF THE EXPLOSION RISK

3.1. THE PERFORMANCE OF THE COMPREHENSIVE RISK ASSESSMENT OF THE POTENTIAL EXPLOSIVE ATMOSPHERE THAT MAY OCCUR AT THE WORKPLACES
- 3.1.1. Assessing the likelihood and duration of the explosive atmosphere.
- 3.1.2. Defining the quantities of the explosive atmosphere (this can be done on the basis of separate regulations, including the regulations on fire protection or technical specifications).
- 3.1.3. Assessing the likelihood of the occurrence and activation of the ignition sources, including the electrostatic discharges.
- 3.1.4. Assessing the impact of the installations and used substances, processes and their mutual interactions on the likelihood of the occurrence of the explosive atmosphere.
- 3.1.5. Assessing the scale of the anticipated effects of the explosion.
- 3.1.6. Assessing the workplaces which are or can be connected via openings to other places in which the explosive atmosphere may occur.
- 3.1.7. Calculating/assessing the level of the explosion risk.
- 3.1.8. Accepting/reducing the level of the explosion risk.

4. PREVENTION OF THE EXPLOSION AND PROTECTION AGAINST ITS EFFECTS

4.1. TECHNICAL MEASURES
- 4.1.1. The description of preventive measures against the formation of the explosive atmosphere.
- 4.1.2. The description of methods of avoiding the ignition of the explosive atmosphere, in particular including measures and methods of antistatic protection intended for workers and technical appliances.
- 4.1.3. The description of methods of mitigating the detrimental effect of the explosion, along with the description of the personal protection measures in order to provide the safety and health protection of working people.
- 4.1.4. The description of supplementary measures against the propagation of the explosion.
- 4.1.5. The employer's information on deadlines for regular inspections of applied measures against the explosion and protective measures against its effects.

4.2. ORGANISATIONAL MEASURES
- 4.2.1. Internal regulations, safety policy of the company, quality policy, etc.
- 4.2.2. Written instructions: general technical instructions, the Health and Safety at Work, subject instructions for normal operations performed in potentially explosive atmospheres.
- 4.2.3. Written permits to perform particularly hazardous activities in potentially explosive atmospheres.
- 4.2.4. Training in the safety and health protection concerning the protection against the explosion.
- 4.2.5. The co-ordination of operations performed by the subcontractors – appointing a person in charge
- 4.2.6. Verifying the general level of safety at the workplace where the explosive atmosphere may occur, in the scope of the protection system against the explosion before it is used for the first time - appointing the verifier.
- 4.2.7. Appointing a person responsible for issuing the permits to perform particularly hazardous activities.
- 4.2.8. The inspection of devices and the supervision over the equipment and performed activities.

PART 3
INFORMATION AND SUPPLEMENTARY DOCUMENTS

1. The reports on classification, site plans of the potentially explosive zones, marking the zones and escape routes.
2. The reports on the inspections of appliances (reviews, maintenance, start-up, standstill) and the supervision over the equipment and performed activities.
3. The verification report on the general safety at the workplace (have all the conditions necessary to ensure the safety been fulfilled and who is in charge of the verification?).
4. Confirmation of completing training and courses- statements signed by the workers.
5. Certificates of competence and professional licenses of the workers.
6. Other supplementary documents (e.g. change cards to the documentation, checklists, etc.).
7. The employer's declaration on ensuring the safety and adequate supervision over their workers at the workplaces where the explosive atmosphere may occur in quantities that endanger the safety and health of the workers by implementing the adequate measures necessary to achieve the goals referred to in part 2 point 3 of this Document.
8. Procedures and escape plans containing hazard warning signals or signs.

The EPD is divided into three parts in order to collect and arrange many pieces of information required by the decree [14] to create consistent subject sections. Regarding official issues, the employer's statements on taking necessary steps required by the law, lists of existing places in which the explosive atmosphere may occur along with their classifications into zones (number and scale of hazards) as well as short and concise description of protection measures are the most crucial elements, according to the authors. Deadlines for inspections of applied prevention/anti-explosion measures and updating the EPD are other important elements. The general information is contained at the beginning of the document (part 1). The information presents the general level of potential hazards and protections that exist in a particular enterprise.

The main part of the EPD (part 2) contains such information on the assessment of the explosion hazard level as: the identification of used dangerous substances, a concise description of processes in progress, a description of the workplaces where potentially explosive atmosphere

may occur, and the presentation of all necessary elements to conduct the assessment of the explosion risk. The latter pieces of information may serve as a separate study and be quoted in the tabular form with reference to the original document. It is important to select a method of the risk assessment for applied types of technologies and for the level of technical complexity of operated process equipment and justify it. The suggestions on "recommended methods of risk assessment" can be considered during this selection.

A more detailed description of the applied technical protection measures against explosion and protection against its effects comprises an important element of this part of the document. This description should particularly refer to the prevention of the formation of the explosive atmospheres and the elimination of effective ignition sources which may occur at the analysed workplaces (with special regards to discharges of static electricity). Further in this part of the document, there are methods of limiting harmful and potential effects of explosions. The organisational measures for the prevention/protection against the explosion (regulations, instructions, permissions, training courses, practical exercises, supervision, marking, co-ordination of subcontractors' actions, etc.) taken in the enterprise should be presented in this part of the EPD. The second part of the EPD illustrates in details the level of potential hazards and protections functioning in a given enterprise, the training level of workers in the scope of anti-explosion protection, as well as measures taken by the supervision and the control of current operations.

And the third part of the EPD may contain the information confirming previously described data on hazards, classifications of potentially explosive zones, applied technical and organisational measures, training courses and other important data. It is recommended to gather the above information in the form of a list containing also documents of the enterprise, with references to a place (department) of their storage and possibly people in charge of those documents.

The employer has a very important task of making a decision on appointing a person responsible for drawing up and verifying the EPD. According to [4], "a person (or people) with at least the fundamental knowledge on anti-explosion and process safety should be an author of the explosion protection document. Such a person should become sufficiently acquainted with a technological process – used substances, physical parameters, apparatus, possible physical and chemical changes and unit operations. If a person responsible for the EPD is not employed in a particular production, storage or another department for which this document is being prepared, they should closely co-operate with technological services and production supervision in order to gain the sufficient knowledge to identify as many hazards, emission sources, effective ignition sources and other related issues as possible". This is absolutely reasonable statement. If the enterprise lacks people with such skills – the task of preparing the EPD could be contracted to a professional consulting company employing experts in fire/explosion protection. The same criteria should be applied while appointing a person/people reviewing and/or verifying drafts of that document.

The employer themselves, i.e. the owner of the enterprise or the plant manager appointed by them and, in larger companies, the CEO or the technical manager – depending on rules adopted by a given enterprise – should approve that document.

Every single person working at workplaces classified into potentially explosive zones as well as technical, technological and production supervision units in a given enterprise should read the prepared and approved EPD. The special emphasize should be put on controlling those workers by their immediate superiors.

The second guide ("Technical guideline...") is a kind of a handbook providing fundamental facts on combustion and explosion. This document deals with the classification of potentially explosive zones, detailed description of various types of ignition sources (with a comprehensive part on electrostatics), processes of the formation of explosive atmospheres (gas, vapour or dust) along with the place of their occurrence and their duration. It also mentions technical and organizational methods of preventing the formation of explosive atmospheres and ways of avoiding their ignition, including the methods of limiting the effects of an explosion. The requirements on protection equipment and systems are presented there. The guide describes the methods of assessing the hazard and risk of an explosion as well as the level of the explosion risk and recommends selected methods to prepare the EPD in various situations. Moreover, it includes the risk acceptance criterion for explosion with the boundary value of 10^{-4} per loss of life / capita / year that has been proposed by the implementers of the project [16] in order to adopt it in Poland while analysing the risk for the needs of the explosion protection document.

Recommended procedures

The recommended procedures mean the selected methods of assessing the hazard and risk of an explosion at workplaces presented in "Technical guidelines" as suggested methods to be used in practice for preparing the EPD. They are divided into two groups. The first group is recommended for simple installation systems, in small and medium enterprises *(SME)* that use flammable chemical substances (predominantly solvents) in their processes. This is a group of methods involving the so called "risk matrix" as the main tool for the final assessment. They are simple expert methods based on the well-known PHA, Risk Score methods and/or tabular lists of assessments. These methods can be easily performed because they are not time-consuming, do not require the staff with professional training or the detailed data on the probability of the failure of the equipment and protection system.

The second group includes methods that are recommended to be used in more complex process installations operating in larger companies. They are semi-quantitative methods: the Event Tree Analysis and the Layers of Protection Analysis. They are more time-consuming and require the professionally trained technical staff. These methods involve the probability data on typical failure events that occur in the process industry and the data on reliability of used equipment and protections. But, in turn, the calculated levels of the risks of an explosion are more credible and accurate. This is crucial for the installations characterised by a high level of technical integration and complexity.

This guide heavily focuses on hazards caused by the electrostatic discharges – one of the most common in the industrial practices and very effective ignitions sources of explosive atmospheres.

The detailed draft of the emergency scenario illustrating the elements of the development of incidents that result in the explosion at the workplaces have been elaborated for ease of conducting the assessment of the hazard and risk of explosion.

This draft contains all elements that compose the course of the explosion and so called "safety barriers", which - if applied for the installation - may break the sequence of undesirable events and protect it against the explosion or mitigate its possible effects. At the same time, the "pre-initial, conditional and initial events" classified into 5 subject groups play an important role because they initiate a chain of reactions that potentially lead to failure and explosions of diversified scale (Fig. 1).

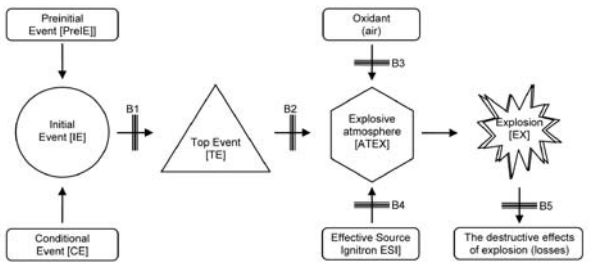

Fig. 1. A sequence of events creating a chain of events that leads to the explosion at the workplace. It enables the formation of the scenario of explosion.
B1–B5 – safety barriers (prevention of the explosion and protection against its effects)

An algorithm for emergency scenarios (Fig. 2) that result in an explosion at the workplace was worked out on the basis of this diagram. The algorithm uses so called "secondary databases" supporting the simple software – "EmergScen" (Fig. 3) [17].

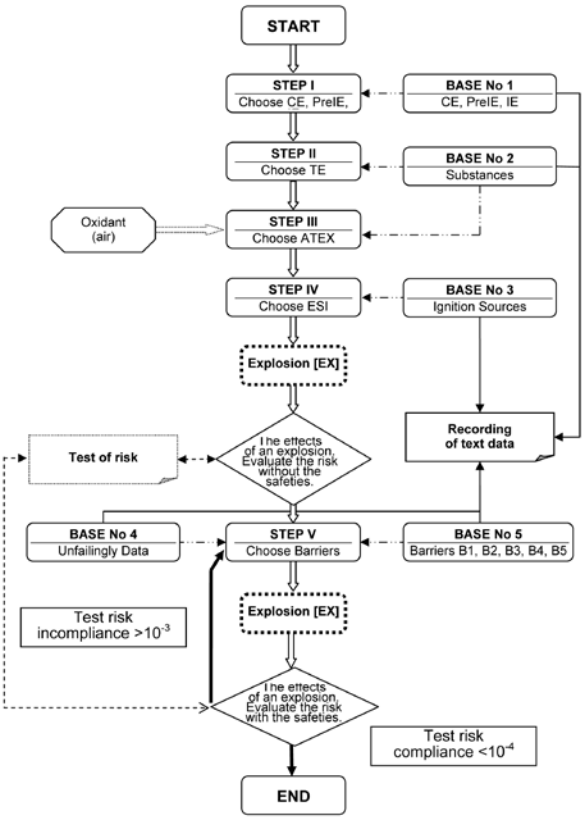

Fig. 2. The algorithm for emergency scenario that results in an explosion at the workplace, supported by secondary databases

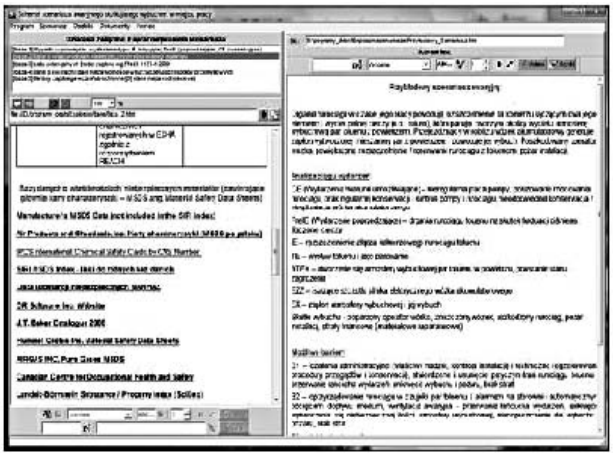

Fig. 3. The main screen of EmergScen programme to create the explosion scenarios according to [17]

The programme is designed to provide support in collecting data necessary to work out such scenarios in the process of preparing the EPD. Five different types of secondary databases were selected and described as below:

Database 1. It contains a list of types of incidents in the industry as well as the events of the following type: initial events (IE), pre-initial events (PreIE), conditional events (CE).

Database 2..It contains the database on properties of dangerous materials / media used.

Database 3. It contains a list of potential sources of ignition according to PN-EN 1127-1:2009.

Database 4.It contains data on failures and reliability data of industrial equipment.

Database 5.It contains a list of protections – safety barriers and their classifications, standards, organisational procedures.

Those databases are in the form of lists or a wide range of links to various kinds of ready databases available in the Internet (for example free of charge, log-in or chargeable databases).

Summary

Over 8 years have passed since the first Polish legal act implementing the requirements of Directive 1999/92/EC into Polish legal status was established in 2003. Meanwhile, 2 amendments were adopted. At first, a small amendment to the decree [9] was adopted in 2006. And in 2010, a new, extended scope of the decree that completely implements all details of the requirements of the above directive was adopted.

Still, the employers of small and medium industrial enterprises know little about the mentioned legal acts, and particularly about their content. For many entrepreneurs, that decree is still a novelty posing significant problems of understanding its expressions and fulfilling its requirements for improving safety of workers at their workplaces, where the potentially explosive atmosphere may occur.

The small entrepreneurs have considerable difficulties in meeting the requirements for assessing the explosion risk at the workplace. This is a key element of any single EPD required by the decree of the Minister of Economy. However, the legislator has not specified any method to assess the risk, not mentioning any suggestions or recommendations. The official specimen of that document (EPD) has not been determined as well. So-far elaborated guides address those problems and help in preparing the adequate EPD even by small enterprises themselves. The standardisation of the framework of the EPD provides its uniform and transparent form that is particularly favourable for the inspections carried out by the State Labour Inspectorate and National Fire Service. It is advantageous to both the entrepreneurs and inspection bodies.

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Polish Noble Prizes for quantum optics, energy and periodontal disease

Professors Tomasz Giaro, Jan Potempa, Maciej Lewenstein and Elżbieta Frąckowiak received this year's Foundation for Polish Science (FNP) Prize for works on the doctrines of law, periodontal disease, quantum optics, energy storage.

This year's winner in the field of Humanities and Social Sciences was Prof. Tomasz Giaro of the Faculty of Law and Administration at the University of Warsaw, for an interdisciplinary analysis of the category of truth in the doctrines of law from antiquity to the present, opening new prospects for understanding of the law as one of the foundations of European civilization. Prof. Giaro was awarded for his work "Römische Rechtswahrheiten. Ein Gedankenexperiment", on the criterion of truth as a tool for shaping the legal norm. "The arguments the truthfulness or falsity were part of the jurisprudence discourse from ancient Rome to the modern German doctrine. Codifications made on a wider scale in the nineteenth century, however, shifted the weight of law creation from science to legislation. Since the legislator +orders, not discusses+, the criterion of truth in law is called into question. Prof. Giaro approaches this question in a broad analysis of ancient sources and later European legal tradition, using the method of thought experiment. Periodontal tissue inflammation, or periodontal disease, is one of the most common infectious diseases. Affected persons are more susceptible to other diseases such as cardiovascular diseases and rheumatoid arthritis. It is now known that a relatively small group of bacteria present in the bacterial plaque below the gum line is responsible for the pathological changes in periodontal tissue. Prof. Potempa's research concerns the role of bacteria. The winner and his colleagues isolated and characterized seven protein-degrading enzymes produced by this bacterium (including so-called gingipain). He proved that gingipains are a key factor in the development of periodontitis and demonstrated that they are responsible for a disorder of the body's immune response, where instead of eliminating the bacteria the body turns against its own tissues. Prof. Maciej Lewenstein of the Institut de Ciencies Fotoniques (ICFO) in Castelldefels and Institucio Catalana de Recerca i Estudis Avancats in Barcelona was awarded in the field of mathematics, physics and engineering for achievements in the area of quantum optics and the physics of ultra-cold gases. In the last decade, Professor Lewenstein focused on studies of strongly correlated ultracold quantum gases. Quantum simulators allow to understand the complex quantum physics of many-body systems, and such phenomena as superconductivity or superfluidity. Research of Prof. Lewenstein also concern matter wave interferometry and its potential applications in precise time and frequency measurement. Professor Lewenstein is considered a world leader in the field of modern physics. Contributing to its development, he expands the knowledge of the fundamental laws of nature. In the field of chemical and materials sciences the FNP Council awarded Prof. Elzbieta Frąckowiak from the Faculty of Chemical Technology, Poznń University of Technology. She was recognised for her research on new materials, carbon composites and their use for electrochemical energy storage and conversion. Carbon materials developed by Prof. Frąckowiak include, in particular, carbon nanotubes and their nanocomposites with conducting polymers and oxides, nanotextural carbons and carbon composites enriched with nitrogen, oxygen and iodine. They are the basis of technology used in supercapacitors. Supercapacitors are devices with a high capacitance, capable of quickly charging and discharging large power values. Their uses include automotive industry (hybrid and electric cars), energy (battery backup systems to stabilizing the power network) and mobile devices. Their properties make them a possible partial alternative to fuels responsible for the high carbon dioxide emissions.

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