PlasmaPrometeo
(www.plasmaprometeo.unimib.it)

Center of excellence for Research, Development and Technological Transfer in the field of applications for plasmas.

The center of excellence for Research, Innovation and Technological Transfer in the field of applications for plasmas arises on **12nd of February 2004** from an agreement between The **University of Milan – Bicocca** and **Regione Lombardia.**

Primary goal for PlasmaPrometeo is to finalize the public research to **support enterprise's system and SME's,** sharing with them the most innovative results coming from the research's activity of the **Plasma's Group** from Physic's Department of University of Milan – Bicocca.

This goal is achieved with the use of European and National funding for research projects, demonstration and technological transfers too, in order to trigger a **funding process** for academic research and **invest** in new applicative research for enterprises.

Hence, **the goals** of PlasmaPrometeo are:

- To create knowledge and enhance research activities developing new technologies in the field of plasmas;
- To enforce progress, promoting technological transfer of new processes and innovative methodologies to industry and SME's;
- To realize synergy between industry and university, in favor of enterprise's competitiveness and technological development of national substrate;
- To educate qualified technical staff in the area of high technology and to transfer new expertness to the companies.

Technological transfer to industry and SME's.

One of the leading goals for PlasmaPrometeo is the research and technological transfer to industries and SME's, thanks to the possibility of orienting its activities toward industrial field and its demands. Hence the center propose itself as "**partner"** for enterprises in R&D for new technologies and their market's insertion.

The presence of PlasmaPrometeo reach European and International levels. The center is a partner of an European network of excellence, **PLASMATECH,** *"Network of excellence for plasma technology for textiles, health, food and environment"* for disclosure and promotion of plasma technologies. Through this network, the center cooperates with several companies and European research centers. The center arises involving primarily Italian corporations. In the future we expect to involve further Italian and foreign corporations.

Services

A list of several services for **companies and SME's** offered by PlasmaPrometeo:

- Collaborations and research's contracts for feasibility's studies, technologies' development, physicochemical analysis on materials and support for Technological Transfer.
- Access to patent's portfolio owned by PlasmaPrometeo
- Development of pre-industrial prototype.
- Scientific and technical advising.

Equipment of the center

PlasmaPrometeo is armed with the most modern equipments and instrumentations, letting the center to carry out an innovative and highly forefront research activity:

- Plasma reactors (low and atmospheric pressure);
- Controls system for processes;
- Diagnostics system for plasmas;
- Instrumentations for material's physicochemical analysis (NMR, IR, EPR, Contact Angle, Surface Energy, AFM, Gas chromatography);
- Systems for ionic implantations and manipulation on nanoscale level for surfaces (Focused Ion Beam, SEM);
- Theoretical models for simulation of gas discharges.

Plasma's industrial applications

The use of plasma's technologies is so widespread that has become a standard process for industrial field, like microelectronic and optical areas.
New technologies are developing nowadays in textile, pharmaceutics, packaging, paper-making, food, cultural heritage areas and etcetera.

This is possible thanks to the conspicuous efficacy demonstrated by plasma's usage and its surprising versatility in surface process, in fact permitting it to displace less flexible technologies.

Additionally, essential are the big advantages in environmental conservation, enrolled with the use of plasma treatments compared to traditional surface processes: in fact plasma technology is a dry process, not requiring solvents or chemical products dangerous for the environment.

Materials

An industrial application for plasma consists on the possibility of modifying surface's properties of many materials in a range from several nanometers to several micron, maintaining the original structural properties: mechanical strength, flexibility, hardness, dielectric properties, etc.

Modified materials can be easily used in various and new applications, even different from the ones they were originally synthesized for.
PlasmaPrometeo has developed technologies for plasma treatment of different materials like: textiles, paper, lingo-cellulosic fibers, leathers, wood, polymers and ceramic materials.

These are the plasma processes generally used to obtain properties like: hydrophobia, hydrophilia, oil repellence, adhesion, gas or flavors or UV radiations barrier, surface rugosity and acid-base properties:

- **Thin Film deposition** of organic (conventional polymers-like) or inorganic (various metals oxides and semiconductors) nature.
- **Specific functional groups grafting**: treated surface can react selectively with complementary "reactive environment" properly chosen.
- **Etching:** removal of superficial layers of inorganic and organic materials. Suitable for composite materials with neat geometry (microelectronics).
- **Activation a/o cross-linking** of substrates to make them more or less reactive to specific environment.

One of the activity of the center concerns the realization of surfaces with anti-fouling properties (surfaces with lowered absorption of protein). Applications for materials with this kind of property are in the following areas: biomedical (contact lens, prosthesis, by-pass) and microfiltration. The center cooperate with Fraunhofer Institute (Deutschland) on research activities regarding cellulose and PP surface's functionalization, based on plasma technology combined with conventional chemical methods.

Environment and Energy

From the very beginning, the research in the field of industrial application of plasma produced very important results for environmental respect and conservation and for energy, in terms of harmful emissions treatment coming from industrial processes and in terms of energy production thanks to energy-saving and low environmental impact methods.
In this way, the activity of the center PlasmaPrometeo appear to be fundamental and strongly at the forefront: harmful gases are transformed in less pollutant elements.
In the center's facilities is furthermore developed a research for hydrogen production by conversion of natural gas. In a test phase the center developed a plasma reformer for hydrogen production.

Cultural Heritage

In the field of cultural heritage, plasma technology developed by PlasmaPrometeo has many innovative applications in the areas of conservation for perishable materials with particular historical and artistic interest, like papery and ligneous materials.
Indeed Surface plasma treatment confers particular properties like hydrophobia and antibacterial, in this way reducing the possibility of artifact's abasement due to chemical agents like acid and atmospheric and biological pollutant (moulds and bacteria).

The plasma treatment do not lead to material's structural modifications and the amount of chemical products used is strongly lower with respect to traditional treatments. This represent and advantage both for economic and environmental point of view.
In fact surface modification is found to be permanent, with excellent results in terms of stability and artifact's aesthetics.
PlasmaPrometeo attends the PRIN 2003 project which lead to the development of an innovative method for ligneous materials' protection.

Textile and Tanning Industry

Textile and Tanning industry represents a field for plasma process applications in which using this technologies can be widespread and rich with advantages.
The treatments found to be suitable for fabrics and leathers are numerous. And numerous are the functionalization of their surface properties too. A modification of this surface properties lead to innovative results like hydrophobia for leathers, wettability enhance, oil repellence, resistance to abrasion enhance, antistatic property, bio-compatibility and anti-stain properties (fabrics).

- *Incision, removal* of a surface layer and fiber's surface cleaning using inert gases like Argon or Helium;
- *Oxidation* of surface layer using oxygen's or air's plasmas;
- *Deposition* of thin film of metals (Aluminum, Silver, etc.) or polymers (Teflon-PTFE, Carbon) on fabric.

In the domain of the PRIN 2002 project applied to textile for surface properties' modification, permanent hydro-repellence has been obtained for natural and synthetic fabrics.
Legambiente and Regione Lombardia recommended the project "development of low environmental impact processes for technical industrial textiles' production with plasma's technologies" presented by Saatiprint Spa and by the center PlasmaPrometeo, for its worthy of mention innovation. Innovation that won the price "Premio all'innovazione amica dell'ambiente 2004".
The center participates actively as a partner to the FESR project, misura 1.9 – Animazione economica- "**TIMaT Tecnologie Innovative per i Materiali Tessili"** (Innovative Technologies for Textile Materials) for the divulgation of plasma's technologies in the objective 2 areas of Regione Lombardia and is developing an atmospheric pressure industrial prototype in the domain of the project "Promozione dell'eccellenza nei meta-distretti industriali della Lombardia" "**Trattamento al plasma dei materiali tessili: sviluppo di un processo e di un impianto per il trattamento a plasma di materiali tessili"** (Plasma's treatment for textile materials: development of a process and a plant for plasma's treatment of textile materials).
Another relevant project is **Industria 2015 – Loro Piana:** in the areas of plasma's treatment for textile materials, PlasmaPrometeo is a partner of an ambitious research project together with Loro Piana and some other SME's and research institutes. The title of the project is the following: "Fabrics and spurn yarns in noble fibers with high performances, treated atmospheric plasma based process". The golden goal of the projects is the realization of an industrial processes based on plasma technologies in order to produce innovative and valuable fabrics with enhanced mechanical and physiological, anti-abrasion, anti-wear and anti-stain properties.

The center participates ad partner in the European project CRAFT **" PLASMALEATHER, Cold plasma treatment for new, high quality water repellent leather: an innovative, eco-friendly technology to enhance the product performances and the competitiveness of European tanneries"** in which has been developed an half-industrial prototype for hydro-repellent leathers production.
Currently the prototype is in the center of excellence's laboratories and we're performing a study for its industrialization.

The center is a partner in the project for excellence dissemination in Industrial meta-districts of Lombardia **"NOBILITAS CORI, Excellence Network for leather use in fashion's world"**, in

which plasma processes are in development in order to obtain properties like printability and dyeability enhance; properties that can be used to obtain decorative effects.

Packaging Industry

For PET plasma treatment has been established the deposition of an inner layer of SiO_2 of 50 nm. By now this treatment is feasible in line, and enhance an oxygen barrier effect, letting an hefty extension of shelf life for those products that are sensitive to oxidation phenomena (beer, juices, flavored beverage).

In the area of packaging has been developed a Research & Education project. In cooperation with the company Plastik s.p.a. and others national research agencies, the center PlasmaPrometeo animated an important project for studying thin film deposition realization with plasma.
The goal of this research project, named "**Anti-adherent thin film realized with atmospheric pressure plasma"** is the study of a prototype for displacement of an industrial process with high economic and environmental impact with a plasma process endued with lower process cost and environmental impact.
The goal of the educational project, named "Education on plasma technologies focused on realization of thin film with PE-CVD" is the training of highly specialized technical staff for designing and modeling of plasma deposition processes in strategic areas like plastic materials and packaging.

Paper Industry

At the moment, good results had been established for hydro-repellence or hydrophilia enhance on paper or fibers, and a research project is going on for printing enhancing and realizing barrier to gas or liquid, involving various atmospheric pressure processes.
Other applications enclose production of anti-flame, anti-static, anti-bacterial, anti-mould and bio-compatible surfaces. Still other features can be obtain, purposeful to different areas, like paper waterproofing after coloration, resistance to oxidant agents, protective coatings, metallization, de-inking enhance through paper modification before printing, product protection form sunlight and UV radiation, polymerization with monomers, synthetic polymers grafting on cellulose and biodegradable depositions.
The advantages of this type of process concerns: chemical solvents' disposal and no need for water.
In this area, the center is lead partner in FESR project, Misura Animazione Economica, "**Permanent Network for Innovation and Technological transfer in paper and paper-technical sectors NePI"**. The goal of the project concerns the dissemination of innovative technologies in the object 2 – areas of Regione Lombardia.
Furthermore, PlasmaPrometeo is developing a research project, named "Plasma and Paper" together with Stazione Sperimentale per la Carta, Cartone e Paste per carta and several paper companies for realization of plasma process for paper industry.