Durable and clean nanocomposite coatings for the car of tomorrow

Magnesium alloys will be a "must" in the near future to reduce fuel consumption and air pollution, as they will play a key role to reach the lower weight targets set by the automotive and aeronautical industries.

Today, a broader use of magnesium is constrained by its susceptibility to corrosion. As a consequence, there is a growing need for European transportation companies to combine efforts, within and across industrial sectors, to develop appropriate surface finishing. The serious environmental problems arising from the use of today's environmentally critical treatment like chromate-based conversion coatings make it urgent to develop "clean" solutions for the European citizen.

Consequently, there is a need to develop new environmentally friendly coatings with enhanced corrosion, and abrasion resistance for the protection of magnesium parts, by using clean and economic processes. This will enable the widespread use of light magnesium alloys and the replacement of the hazardous coating processes that are used at present for the different applications of magnesium parts in the automotive and aerospace industries.

The Market

39% of all magnesium has been used in die casting in year 2000 (+21% in 1999). Explosive double-digit growth is expected in this sector, driven by demand from the automotive sector. The use of magnesium alloys in the automotive and electronic industries has grown by 350% over the past 10 years and is expected to grow at 25% per annum until 2008.

The International Magnesium Association has reported for 2001 a total amount of 112 000 tons for the primary magnesium alloy consumption for die casting, gravity casting and wrought products across the world, with the following distribution: US & Canada - 48%, Western Europe - 32% and Asia/Oceania - 13%.

The production of new anti-corrosion and wear resistant nanocomposite coatings will create considerable new market opportunities for magnesium alloys in various industrial sectors, coating centers and magnesium alloy producers.

Key industrial sectors that would benefit from the innovative coating techniques are:

- the automotive industry, where the need is for solutions which reduce fuel consumption and the environmental impact of transport.
- the aviation industry, where the demand is to reduce fuel consumption (as highlighted in the Fourth Community Aeronautical Days, Hamburg, January 2001).
- the space industry, where the need is to reduce the weight of components.
- the electronic industry, where the requirement is to create a new generation of lightweight, rugged, shock-proof and vibration-proof cabinets, casings and enclosures (for example, for laptop computers and mobile phones).

Innovations

The main success of the project is expected to be the substitution of standard coating processes, critical in terms of costs and environmental impact, by innovative clean processes, optimised in terms of production costs, obtained by nanoengineering techniques.

This will reduce emissions, effluent and waste and increase the use of lightweight magnesium structures and components and will bring to:

- ***A wider use of magnesium*** in different areas of human life.
- ***The development of highly corrosion and abrasion protective coatings*** specifically adapted for and applied to magnesium alloys used in Automotive and Aerospace applications.
- ***The introduction of new clean, environmentally friendly*** and ***economic coating*** processes, to enable the ***replacement of hazardous protective coating*** processes and materials.
- ***The promotion of sustainable and environmentally friendly mobility***, as a more extensive use of magnesium alloys will lead to lower fuel consumption with a consequent reduction in CO_2 emissions.

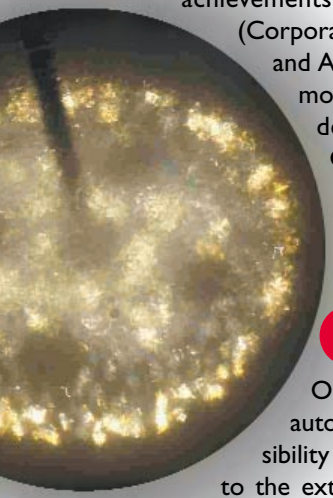
These innovations will have a major impact on the quality of life of the European citizens, not only through the elimination of polluting substances and dangerous chemicals (hexavalent chromium) during the coating processes, but also by the reduction of pollution through an improvement of the efficiency of cars, leading to cleaner, healthier, urban environments.

The Project Team

The project brings together scientific and technical expertise from all over Europe to develop the innovative coating processes needed for widening the applicability of magnesium alloys.

The project team is a combination of research institutes, industrial research centres and end users, sharing knowledge and expertise and gathering complementary skills. The **Università degli Studi di Bari**, assisted by the research facilities of the Joint Research Centre of the European Commission at the

Ispra site (plasma processing, plasma-surface interaction, *in situ* plasma diagnostics) and the **University of Patras** (plasma diagnostics and modelling, *in situ* measuring of deposition rates and thickness uniformity) undertake the development of PECVD coatings. The **Politecnico di Torino** and **Fundacion TEKNIKER** have facilities and wide experience in electrochemical, wear and friction characterization at basic, simulated, micro and macro levels, and lifecycle analysis. PACVD and Sol-Gel technology are treated by **CSEM S.A.** (possessing experience on wear resistant and corrosion protection coatings, solid lubricants, surface treatment and deposition technologies, and micro and nanoscale characterisation in terms of structural, interfacial, mechanical and tribological properties). While the technology scale-up to the industrial applications is carried out by **Archer Technicoat Ltd**. (PECVD equipment designer and constructor), **KERONITE Ltd** (developer of the innovative plasma-electrolytic oxidation coating process and coating equipment) and **GENTA** (of the **T.T. Ferioli & Gianotti S.P.A.** group - PAPVD coatings supplier), four end users ensure the exploitation of the project's achievements: **EADS Deutschland GmbH** (Corporate Research Centre in the Aeronautical and Aerospace sector), **Tarabusi S.A.** (automotive supplier with experience in design, development and testing of pistons), **Centro Ricerche FIAT S.C.A.** (Automotive Research Centre) and the **Magnesium Research Institute** of Israel (magnesium alloys developer) .



An application example

One of the most important aspects for the automotive industry of the future is the possibility to extend the use of magnesium alloys to the external components of the car. The door frame certainly represents an important challenge, from the point of view of casting, but also from that of the high corrosion resistance required for the structure where joined to dissimilar materials (salt presence on the road, polluted air, galvanic corrosion).

Other important application examples for the innovative coatings are the protection from corrosion (for covers, housing, cases, structures, etc.); hard, scratch-resistant undercoats for paint, lacquer or top coats; and wear and erosion resistant coatings (for bearing surfaces, turbine components, etc.).

Glossary

***PECVD**: Plasma Enhanced Chemical Vapour Deposition.*

***PAPVD**: Plasma Assisted Physical Vapour Deposition*

***Sol-Gel**: A process in liquid solution, which, by means of hydrolysis and condensation reactions, leads to the formation of ceramic materials.*

***KERONITE**: Hard and corrosion resistant electrolytic ceramic surfacing for magnesium.*

Development of Innovative Nanocomposite Coatings for Magnesium Castings Protections

NANOMAG

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PECVD equipment developer and producer
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Coating job shop centre
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Magnesium Research Institute *Beer-Sheva (ISR)*
Magnesium alloys R&D
http://www.dsmag.co.il

KERONITE Limited *Cambridge (UK)*
Developer of KERONITE process and equipment
http://www.keronite.com

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