

★ New Ionic Liquid Solvent Technology promises to transform metal finishing products worldwide says **Dr Uwe König**, of IONMET, whose project he says will provide the prerequisites for SMEs to apply the innovative capability of surface finishing and printed circuit board manufacture

# Transforming Metal Finishing Processes

Traditionally, techniques for electroplating and metal finishing have been based on aqueous chemistry – something that has effectively limited the range of possible metal finishes and their processes. Further, existing solutions for the processing of metal finishing have contained dangerous and highly corrosive chemicals, which are very complicated to use to ensure an adequate environmental oriented handling. IONMET (New Ionic Liquid Solvent Technology to Transform Metal Finishing Products and Processes) – a four-year funded research project encapsulating 33 partners from 11 EU countries – however, is revolutionising this field with a brace of radical new technologies based on a generic group of ionic liquid solvents.

## Developing systems of Ionic Liquids

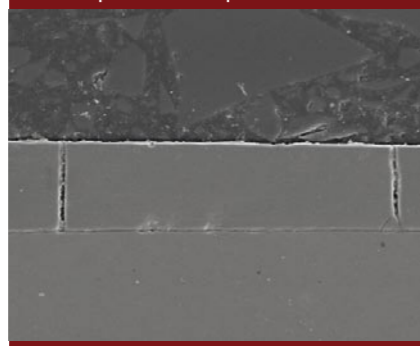
Ionic liquids are, in principle, ionic solvents which melt at less than 100 degrees Celsius – often at room temperature or below. High temperature melts are commonly referred to as ‘molten salts’ or ‘fused salts’, with salts in the liquid phase at low temperature described as ‘room-temperature ionic liquids’ or ‘liquid organic salts’. The composition and properties of ionic liquids are determined by the combination of cations (positively charged ions – formed when an atom loses electrons) and anions (negatively charged ions – formed when an atom gains electrons), and their resulting differences in structure and intermolecular interactions. This delicate interplay allows scientists to then mix-and-match a number of small anions and a great diversity of large cations to produce ‘designer solvents’, customisable to suit a myriad of particular needs such as dissolving chemicals in a reaction or metal finishing under stable chemical conditions



Ti and Ti/Al alloy, Ta6V, chemical depassivation (acid); electropolishing in Ethaline bath



IONMET coating facility and workshop for ionic liquid solvents



Cross section of a deposit on steel (thickness: 30 µm)

Dr Uwe König, linking IONMET to the plating industries, elaborates on the dynamic nature of ionic liquids:

“Ionic liquids have the potential to combine the increase of the chemical

stability of the solvents with a higher reactivity of the dissolved metals and thus lead to more efficient processes with higher product yields and reduced waste. They are highly conductive, in general non-inflammable and have a very low vapour pressure, which makes them less dangerous than conventional volatile solutions. This radical new generic technology will enable the introduction of a large number of totally new products and processes, which cannot be produced using existing technology.”

## Applications

Indeed, the new technologies IONMET bring to the field are highly relevant to a very large number of SMEs and OEMs due to the generic and wide-ranging nature of their potential applications. Currently, with the project in its fourth and final year, six areas of application for ionic liquid have been identified, researched and had their potential for economic integration and success examined. These are:

- **Hard and Decorative Chromium** – Traditionally this process is based on Hexavalent Chromium and has been notable for its high-level of danger and complicated production process with a small efficiency. However, under the IONMET project a new approach – using a solution of ionic liquid – has been formed which is both higher efficient and easier to handle in environmental habits. The solution is prepared through dissolution of Trivalent Chromium Chloride in Choline Chloride. Nevertheless, traditional aqueous solutions are also developed using Trivalent Chromium with comparable characteristics. Both technologies have to face the resulting competition.

- **Zn Alloys and Novel Alloys – Coatings** on mild steel substrates have been prepared using deep Eutectic Solvent electrolytes based on a mixture of chlorine chloride and ethylene glycol, and processes have been scaled up to a large laboratory scale. The advantages of these coatings include the elimination of hydrogen embrittlement in aerospace applications and a lower environmental impact.

- **Aluminium Deposition** – Conventionally – i.e. in aqueous baths – the coating of certain metals is impossible. However, thanks to IONMET’s research on ionic liquid solvents, a new process for aluminium electroplating on steel samples has been created that is easier to handle than the process based on non-aqueous electrolytes currently under use. In addition, the project has significantly increased knowledge in the fundamentals and control of electrodeposition process parameters. A pilot rig is also being constructed at C-Tech (UK-based technology development company) that is sized to allow Al coated samples with a surface up to 400 cm<sup>2</sup>.

- **Plating on Magnesium and Titanium** – Presently it is very difficult to coat magnesium electrochemically by any metal in aqueous solutions as it reacts extremely with water, forming loose corrosion layers. However, air and water stable ionic liquid has been successfully used as an electrolytic solvent for electrodeposition of Zn onto Mg alloys. The corrosion rate of the ionic liquid is four orders lower in magnitude as that of the aqueous electrolyte.

- **Electropolishing** – IONMET have developed a new process for electropolishing stainless steel and Nickel-based materials. The operating conditions are similar to the existing acid-based solutions but provide simple drop-in technology at lower costs. The benefits of the new process include: Non-acidic formulation and non-corrosive; improved surface finish on cast pieces; a four-fold improvement in efficiency; reduced and simplified waste treatment; less gassing, and recoverable metal waste.

- **Silver and other Electroless Coatings** – Electroless deposition of silver on to a copper substrate has been achieved by

IONMET. The process is designed for silver plating on multi-track circuit boards with a less chemical degradation. The operating conditions are the same as the existing water-based solutions and benefits include: the possibility of thick, bright, adherent silver layers; reduced light sensitivity of solution; decreased soldering temperature; uniform deposition rate; non-acidic formulation, and non-cyanide.

Whilst promising however, at this stage of testing, König says that IONMET’s remit is not yet complete, as to implement these ionic liquid technologies into industry there are various issues that need to be worked through. “The target of IONMET to find ways to apply the technology of ionic liquids to the industry requires an analysis of the needs and demands of SMEs,” notes König. “With an increasing amount of knowledge the definitions of these requirements become more and more important. A number of questions result from various discussions inside the project itself and with other plating companies regarding issues surrounding technical acceptance, market chance and human acceptance.”

Regardless however, it would seem that the commercial potential for ionic liquid solvent technology is strong and – excitingly for a project of its field – makes real headway on environmental issues, providing safer and more efficient finishing of metal products and circuit board manufacture developing new market segments. ★

## The IONMET 3rd Industrial Workshop

On the 24th of March 2009, IONMET held their third industrial workshop entitled, “Application of Ionic Liquids in Plating Technology”. Here notable academics in the field addressed and discussed the excellent progress made within the IONMET project thus far to a large number of representatives from plating industries and end users. The potential implementations of IONMET were broken into two categories – Application in Plating and Handling of Ionic Liquids – each containing four topics covered by IONMET’s remit. These ranged from in-depth analyses of the environmental and waste management issues, to individual advances in plating technologies (especially Aluminium plating and electropolishing), to an overview of commercial and toxicological assessments.

## At a glance

**Full Project Title**  
New Ionic Liquid Solvent Technology to Transform Metal Finishing Products and Processes (IONMET)

**Project Partners**  
For full list of 33 partners please visit the IONMET website  
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Dr Uwe König



Project Lead

Dr König studied Chemistry at the Heinrich-Heine-University Düsseldorf where he completed his PhD in chemistry and electrochemistry. His main fields of interest is the linking between basic research and application. The scientific topics he is involved in covers amongst others the development of efficient plating processes, preparation of guidelines for sustainable plating processes as well as the analysis and comparison of coating technologies. Since 2007 he is CTO of the Zentralverband Oberflächentechnik ZVO e.V., Germany.

