MOLTEN SALT ELECTROCHEMISTRY: 
PRESENT AND FUTURE PRIORITIES

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Molten salt electrochemistry is by no means a new research area. Some of the initial experiments go back two hundred years in history (e.g., electroreduction of alkali metals) and such an important metal as aluminum has been produced for more than hundred years by an electrolysis of a molten salt electrolyte (the Hall-Héroult process).

However, molten salt electrochemistry is a very dynamic scientific and industrial area of electrochemistry looking not into the past but into the future.

There are numerous important technical areas in molten salt electrochemistry. In some of these areas enough knowledge have been accumulated to develop qualitative improvement and often parameter optimization:

(i) Electrochemical production of metals is one of the most mature areas. In connection with aluminum production the main aim of developments is to obtain a higher efficiency of the process and to solve serious ecological problems.

(ii) Electroplating of protective layers on metal surfaces. The recent developments are mostly concerned with the electrodeposition of refractory metals from molten salt electrolytes. The most important problem in this technology is control of the composition of the molten electrolytes. Another problem with refractory metal electroplating can be illustrated with the help of the example of tantalum deposition. Two different crystal forms of tantalum can be obtained electrochemically: α- and β-tantalum. The deposit with the α-form has better mechanical properties than that consisting of the β-form. Therefore, the problem of the optimization of the electrolysis parameters has to be solved with allowance for this special factor.

However, the most interesting scientific results and applications are expected in the new areas of molten salt electrochemistry:

(iii) Metal alloy production is an area with a considerable potential. This technique gives a possibility to obtain, for example, the alloys of aluminum with lithium (metals with high and low melting points), or in general alloys which are difficult to make by a direct combination.
(iv) **Electrodeposition of amorphous metal layers** is a technique which can be realized in molten salt electrolytes and may be the background for progressive technologies for the production of highly corrosion resistant materials.

(v) **Electrosynthesis of superhard materials.** Many such materials can be obtained electrochemically from boron-, carbon- or nitrogen-containing melts. This could be a relatively cheap technology giving a useful modification of metal surfaces. To the same area we can add the high temperature electrochemical technologies for the improvement of surface properties of superhard materials with electroplated metal layers.

(vi) **High-temperature electrocatalysis** is a process in which material is consumed or produced in an electrochemical reaction on a catalyst that is an electronic conductor. Obviously, the currently most interesting and important cases in this area are the molten carbonate fuel cells. The main problem here is to obtain non-soluble and catalytically active electrode materials.

(vii) **Electrochemical promotion of catalysts** deals with the change of activity or selectivity of molten salt catalysts using inert electrodes. It can provide an effective management concerning quality and composition of the products of the catalytic reactions.

(viii) **Hot corrosion** has the possibility of becoming a very important area of molten salt electrochemistry taking into account the perspective of combustion of new types of fuels or traditional but low quality fuels. It has been proven that the most severe hot corrosion problems are caused by a thin molten salt layer on the surface of the exposed metal and therefore have an electrochemical nature. Another example where hot corrosion is important is provided by high-temperature batteries and molten carbonate fuel cells. Electrochemical techniques can be powerful tools in searching for new ways of corrosion protection.

(ix) **High-temperature electrochemical protection from corrosion.** Cathodic and anodic protection are well known and widely used at ambient temperatures but have not to any extent been used in connection with hot (or molten salt) corrosion. For example, in connection with fire tube corrosion in boilers at power stations electrochemical protection can be one of several possible ways of prolonging the lifetime of power-station hardware.