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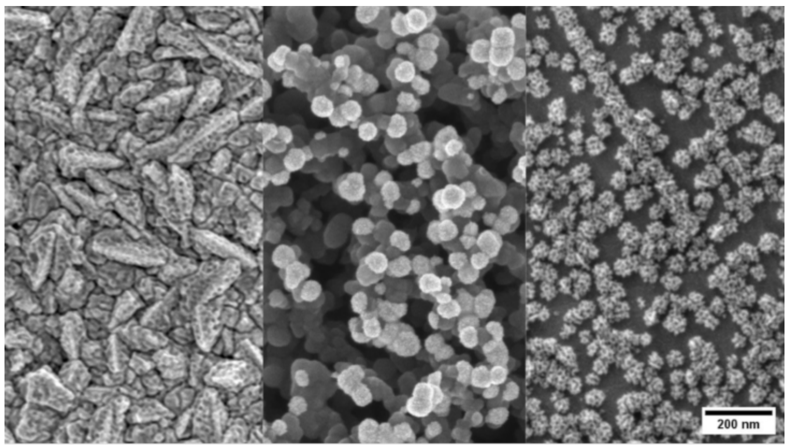
Nanostructured materials by electrodeposition



Electrodeposition - the deposition of metals and alloys by electric current - opens the door to the creation of new metallic materials that are used in the production of biomaterials, electronics, jewellery, etc. In this article, a group of researchers from the Department of Physics presents the advantages offered by this technique, which can be translated into an increase in efficiency, a reduction in cost and a greater sustainability of the materials produced.

Electrodeposition is a very simple method **to create novel metallic materials** for nearly any field of application. It is widely used in coatings for electronics and printed circuits, biomaterials, jewellery, as well as in the automotive and aviation sectors where they serve as a corrosion protection. The simplicity of this process allows the deposition of various metals and metallic alloys whose structure is dependent on the process parameters.

We can establish an analogy with the preparation of a dish. First, we prepare a broth, in a way that we add salts and spices to water. In electrodeposition, our salts contain the metals which we want to obtain in the product. The other spices we are adding ensure the success of the resulting dish, or, in other words, the quality of the materials we obtain in terms of purity, homogeneity, roughness, and others. With the broth at hand we can continue with the actual electrodeposition process. In cooking, we use to play with two parameters: time and temperature. Here, a third parameter comes into play which makes the deposition **an "electro"-deposition: an electric current**. Apart from these principal parameters, we need to consider other aspects which are the same as in cooking: if we should stir or not, and in what order the ingredients should be added. All of these will affect the final result.

And because tastes differ, the process may be adapted in order to satisfy any specific taste. Except that in the field of materials we don't speak of tastes but rather of requirements. These requirements may refer to **mechanical, magnetic, electronic, or thermal properties, or to requirements in composition, weight, or simply the cost.**

In our work* we are using electrodeposition to achieve the simultaneous deposition of two different elements, nickel and platinum, which leads to the formation of an alloy. **By varying the applied current during the process, we can virtually choose our alloy's composition "à la carte".** As a result, by choosing the composition, all composition-dependent properties such as mechanical and magnetic properties are in a way predetermined. One of the major findings we demonstrate in this study is the ability to manipulate the Curie temperature, the temperature below which the material is (ferro)magnetic. Starting from pure nickel at 360 °C, we were able to lower the Curie temperature down to room temperature as a result of the alloying with platinum, along with the alteration of other important magnetic properties.

Thanks to the fact that the properties of a material may be chosen "à la carte", various fields of application requiring precise mechanical, thermal, or other properties, are opening up. The ability to adjust the magnetic behaviour of an alloy in a very controlled fashion **opens the way towards application in microelectromechanical systems actuated by magnetic fields**.

Another very promising field of application of the nickel-platinum alloy is **in energy conversion**, given that this material can act as a catalyst. In this case, the facility of adjusting the composition allows us to find a compromise between efficiency, cost, and sustainability. Moreover, one of the "spices" used in the electrodeposition process (a copolymer) facilitates the introduction of nanoporosity in the material (see image), leading to an enormous increase in the surface-to-volume ratio while the amount of material used is considerably less. In consequence, the efficiency increases, and the cost is reduced.

In an intent to gain even more flexibility in the selection of material properties, and to guarantee an improved corrosion resistance, **our research currently concentrates on the electrodeposition of ternary systems**, containing three different materials (nickel, platinum and molybdenum).

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References

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