Materiali avanzati
Advanced Materials

DII research group
Metallurgy

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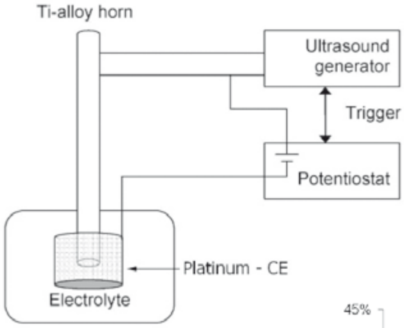
Main research topics

- Novel anti-wear and anti-corrosion coatings on light alloys
- Study of microstructural evolution of high-alloyed stainless steel
- Electrotytic plasma oxidation of light alloys
- Recovery of metals from steelmaking residues by means of hydrometallurgical methods
- Production of metal nanoparticles

Effects of Synthesis Temperature on Behaviours of FeCo Nanoparticles Produced Sonoelectrochemically

The study describes synthesis of FeCo nanoparticles by using the sonoelectrochemical technique, a method which couples an electrochemical process with the employment of high power ultrasound, as shown in Fig.1. The effects of synthesis temperature on process efficiency was visible in Fig.2.
Generally the increase of T enhances metal salts solubility and as a consequence bath's conductibility and ions mobility rise too, and diffusion processes are hence accelerated; moreover the diffusion layer regenerates quickly after each electrochemical pulse and contracts because of thermal agitation, while solution viscosity decreases.
These aspects, combined to the possible thermal activation of nucleation sites, should increase the limiting current of the electrochemical process and the global process efficiency in terms of nuclei population density. In spite of all these benefits the global yield decreases at temperature over 40° C and reaches the maximum value at room values. On the other hand, high temperature furthers Fe(II) to Fe(III) oxidation and hinders iron reduction at the electrodic surface; moreover it is likely that the high temperature accelerates redissolution phenomena of the small nanoparticles in the electrolyte. At temperature below the room value, bath's viscosity and difficult ions migration obstruct reduction processes; so the best compromise among these opposite conditions was found to be a synthesis temperature of between 25° and 40° C. From XRD measurements the grain size increases with bath's temperature from about 10 nm to almost 30 nm. It can be explained in terms of growth rate of metal nuclei on the cathodic surface; at higher temperatures growth prevails on nucleation processes and the final consequences are a small number of nuclei formed on the cathode, a drop in yield and the achievement of bigger nanoparticles. The opposite is observed at lower temperature because of mass transfer phenomena, which control the growth rate of nuclei, are slowed down

Fig.1. Schematic of the apparatus for nanoparticles production.



Sample	T / °C	a / Å	Grain size / nm
FeCo1	10	2.86	8.6 ± 0.3
FeCo2	25	2.84	12.3 ± 0.5
FeCo3	40	2.85	25.1 ± 1.3
FeCo4	60	2.86	28.1 ± 1.4

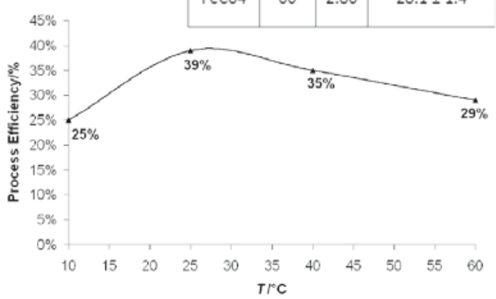


Fig.2. Effect of bath's temperature on final process efficiency