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Sonochemical nanostructuring of Cu-Zn alloy

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Nanostructured materials have been intensively studied because of their unique physical and chemical properties. Preparation of nanocomposites and nanostructurization of bulk materials are of the most popular topics in modern chemistry. Among existing preparative methods, sonochemical treatment is one of the most promising and interesting. Sonochemistry is based on the phenomena of acoustic cavitation, which is the formation, growth and implosive collapse of bubbles in a liquid being subjected to extensive ultrasonic irradiation. As a result of the extreme conditions during cavitation bubble collapse, a number of different physical and chemical processes are initiated.
The implosive collapse of bubbles generates a shock wave that propagates into the liquid medium. It makes ultrasonic irradiation an effective techique to mix liquids, erode solid surfaces and facilitate interparticle collisions. Since a lot of industrially important chemical processes use catalysts and these are often are produced in a very complex reactions and include such expensive elements as platinum or palladium, the importance and economical benefits of using brass as a catalyst are obvious. The ultrasonic treatment provides the surface activation of usually chemically passive metals and alloys at a low cost.

The aim of our research is to activate surface of readily available and cheap brass and enhance catalytic activity of copper and zinc ions. Such effects can occur in three distinct stages: (i) during the formation of supported catalysts, (ii) activation of preformed catalysts, or (iii) enhancement of catalytic behavior during a catalytic reaction. In this work we focus on the second approach due to its least cost and its versatility.

In our work we used copper-zinc alloy (brass) in forms of powder and flat plates. Powders were used as furnished, plates were cut from a single sheet, grinded on a sandpapers and polished on progressively smaller diamond powders with the ending step of 0.5μm. Then samples were exposed to high energy ultrasonic treatment.

A series of samples was exposed to ultrasonic irradiation of different intensity, the samples were studied with a number of methods including optical and scanning electron microscopy. For two samples electron backscatter electron diffraction (EBSD) maps were constructed and microhardness by Vickers method was measured.

Electron backscatter diffraction data shows that initially brass consists of grains up to 100 μm^2 in area. Metal surface after intensive irradiation undergo shockwave deformations which do not decrease grainsize, but greatly enhances internal misorientation degree which can result in significant increase in active sites' number and thus in catalytic activity of both copper and zinc. The effect of surface modification quickly decreases under the sample's surface and is neglectable at the distance of several micrometers. It was shown that brass alloy does not change its surface hardness which means that perspective catalyst may be used in almost every field where brass is mechanically applicable.