USING NOVEL METHODS (SONOCHEMISTRY, MICROWAVE HEATING, AND SONOELECTROCHEMISTRY) FOR THE FABRICATION OF NANOAMORPHOUS AND NANOCRYSTALLINE MATERIALS.

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Abstract

In my presentation I will describe the development of novel methods towards the fabrication of important materials. Examples will demonstrate how sonochemistrycan be used to prepare to prepare nanoamorphous and nanocrystalline materials. We will also present results where nanomaterials were synthesize by employing a Microwave oven, and by a sonoelectrochemical method.

Ultrasound radiation is used to synthesize a variety of mesoporous materials[1, 2]. The reaction time is considerable shorter than the conventional sol-gel method. The product has thicker walls and is more hydrothermally stable. Ultrasonic waves are further used for the insertion of amorphous nanosized catalysts into the mesopores. A detailed study demonstrates that the nanoparticles are deposited as a smooth layer on the inner mesopores walls, without blocking them.

When the ultrasonically prepared composite, is used in catalysis a high conversion into products is obtained.

The examples that will be presented are the deposition of MoO_x, and CoMo oxide into MCM-41 as well as into Al-MCM-41[3]. The composite was used in the hydrodesulfurization (HDS) of dibenzothiophene (DTB). We have also anchored Fe_2O_3 into the mesopores of titania[4]. This composite was used in the oxidation of a hydrocarbon, cyclohexane, under mild conditions.

Metals such as iron are easily oxidized. The oxidation of their nanoparticles is sometimes dangerous. For example iron nanoparticles are pyrophoric. We have recently succeeded to fabricate sonochemically nanoparticles of iron that are air-stable[5]. They are coated by an Fe_3C/Carbon layer which prevents their oxidation. The saturation of magnetization ,M_s, of these particles is 240 emu/gr making them a highly magnetic material.

Instead of cooking food in a Microwave oven we are preparing nanoparticles. We have applied the polyol method in the fabrication of nanoparticles binary[6] and ternary chalcogenides[7]. The role of the ethylene glycol as a solvent and a reducing agent will be discussed.

Sonoelectrochemistry is used as a method for the formation of nanomaterials. We will show how by varying parameters such as temperature, ultrasonic power, and electric pulse width, we can control the particle size[8].

Finally, we will present our chemical method for the preparation of multiwalled carbon naotubes (MWCNT), and carbon nanoflasks[9]. We have recently submitted a paper for publication reporting on a chemical reaction between $Mo(CO)_6$ and Mg. The nature of the product in the SEM picture below will be discussed in my talk.

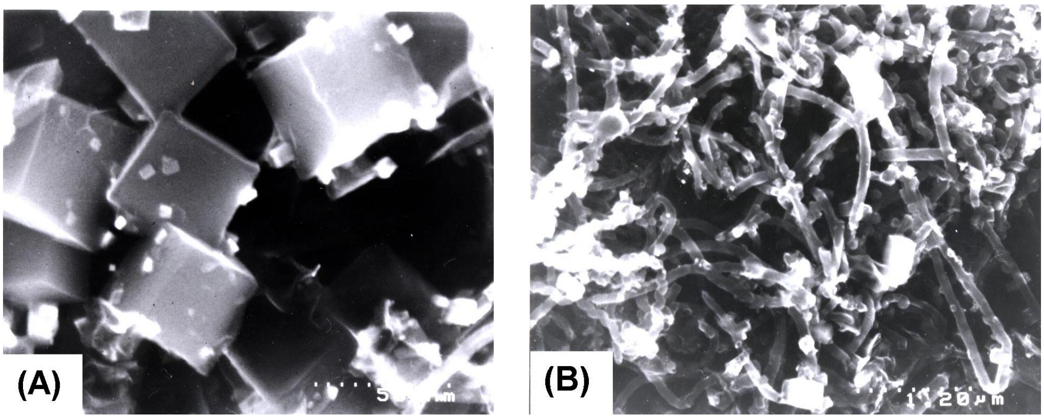

Figure 1. SEM of the product after the HCl treatment (A) this picture reveals an area rich with cubes, (B) many CNT and a much smaller amount of the cubes.

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