E. Korin and A. Bettelheim
Department of Chemical Engineering, Ben-Gurion University of the Negev
ekorin@bgu.ac.il, armandb@bgu.ac.il

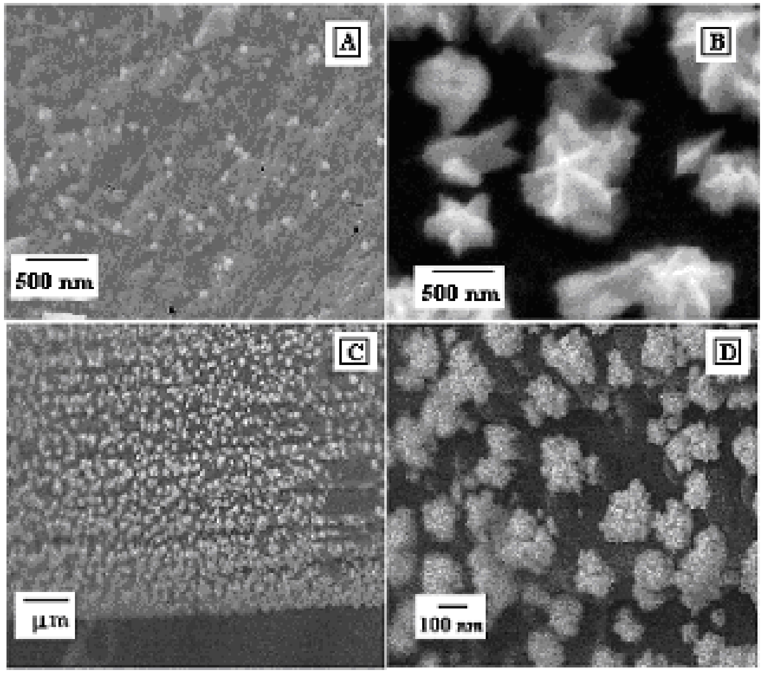
Main research activity: Incorporation of catalytic nanoparticles in mesoporous substrates and their application as electrodes in electrochemical energy and water treatment devices.

Keywords: metal and metal oxide nanoparticles, electrocatalysis, porous electrodes, fuel cells, water treatment.

Motivation: The electrodes commonly used in fuel cells are based on expensive noble metals as catalysts. Our research is aimed towards development of nanotechnology methods for lowering metal loadings and replacing them by non-noble catalysts (macrocyclic compounds, such as metalloporphyrins).

Development of new electrodes based on nanosized catalysts entrapped in polymeric cages

Method: Incorporation of a monomer (4-vinyl pyridine) in the pores of an aerogel carbon electrode, polymerization and cross-linking within the pores (by a dibromoalkane), followed by adsorption and subsequent chemical or electrochemical reduction of a metal salt (such as $PtCl_4^{2-}$). The method allows direct introduction of the catalyst in the electrode pores.



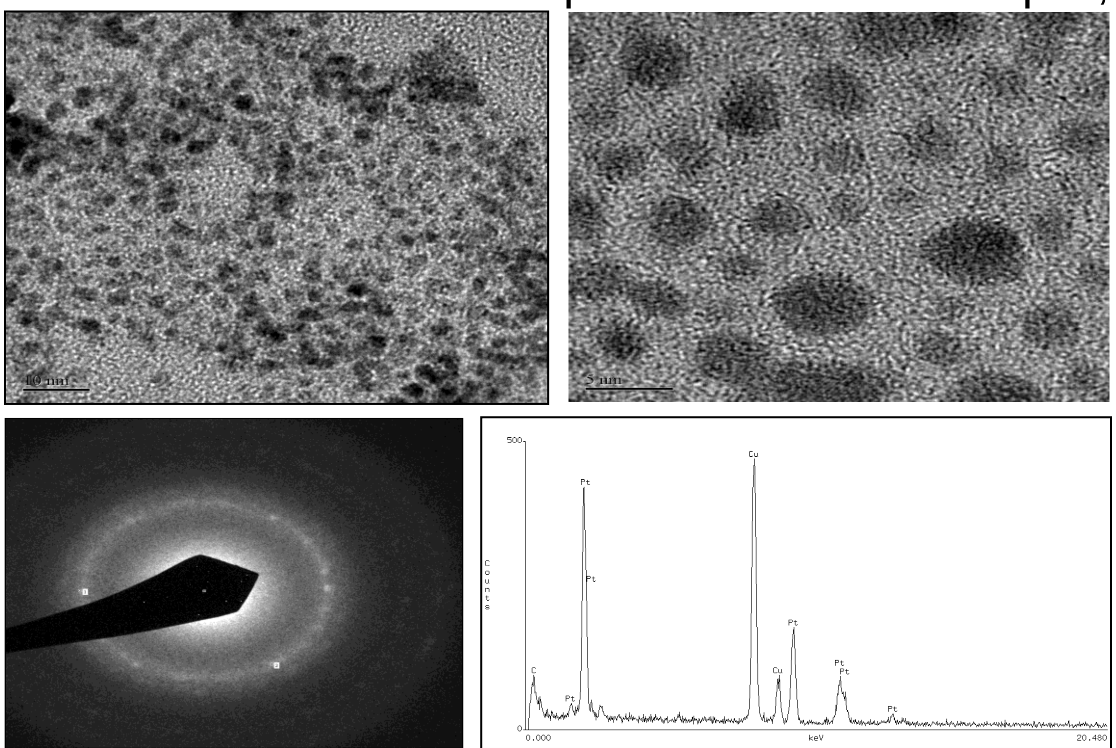
SEM cross section micrographs for particles of: Pd (A), Au (B) and Au-Pd alloy (C)&(D), embedded in cross linked poly(4-vinylpyridine) and incorporated in aerogel carbon.

Use of “green” ionic liquids as solvents for nanomaterials deposition

<u>Concept:</u> due to their unique physical properties, ionic liquids allow to chemically (or electrochemically) reduce metal ions to their stable nanosized metal state.

<u>Method:</u> after the reduction of the metal ions, the ionic liquid with the nanoparticles is introduced into the porous aerogel carbon. The metal particles remain entrapped in the electrode while the ionic liquid is easily removed.

TEM images and XRD obtained for Pt nanoparticles in an ionic liquid, 4 weeks after their preparation:



Present Achievements

1. The two methods (polymeric cages and ionic liquids) stabilize nanosized catalyst particles. The "polymeric cages" enable to form alloys, such as Pd_xAu_y, directly into the substrate pores.

2. Pt nanoparticles introduced by either method, show appreciable catalytic activity towards oxygen reduction at very small noble metal loadings(0.1- 0.2 mg/cm^2 , compared to 1-2 mg/cm^2 commonly used in fuel cells).

3. Recent results show that it is possible to replace noble metal catalysts by macrocyclic compounds (metalloporphyrins) based on non-noble metal ions (Co(III)).