INVESTIGATION OF NANO-PARTICLES MANUFACTURED BY ARC PLASMA AND CONTROLLED DETONATION PROCESSES

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SUMMARY

The aim of given study was to characterize different nano-materials (powders and suspensions with averaged grain size below 1000 nm) and to investigate nano-particles behavior in different media at various conditions.

The investigation was directed mainly to the hard nano-particels such as detonation nano-diamond related materials, nano-Zirconia, nano-SiC and nano-Alumina which present clear and growing interest for the fields of metal electroplating, electroless metal deposition, nano-abrasives and nano-composites. Magnetic nano-particles such as nano-irons with different carbon shells were also involved in investigation as perspective materials for fluid magnetic actuators, magneto-sensors and drug carriers.

Followed evaluation methods were used:

- Photon Correlation Spectroscopy / PCS (Z-Potential of particles in different media, size distribution analysis)
- Ultra-centrifugation / UC (size distribution analysis of smallest fractions)
- Transition Electron Microscopy / TEM (with digital image analysis – direct size distribution analysis, particle shape and morphology)
- Electron Diffraction analysis
- Liquid Nitrogen porosimetry, adsorption isotherms for CO_2 and CH_4 (specific surface of nano-materials in dry state, contribution of polar component nano-particle surface)
- Raster Electron Microscopy / REM + EDX (local chemical composition, approved by Atom Absorption Spectroscopy)
- Wear resistance, friction coefficient, hardness, morphological, metallographic and elemental analysis of different metals plated together with different nano-particles (composite inclusion plating)

Conducted study showed that all investigated nano-particles should be considered as composite particles with sufficiently different chemistry at the particle's surface and in the bulk.

It was found, that most of detonation and hot plasma synthesized nano-powders demonstrate bi- and tri-modal grain size distribution which could be due to synthesis conditions. Appropriate fractions can be separated from each other using PlasmaChem's nano-fractionalization method. The big irreversible agglomerates of nano-particles could be also effectively removed from the material.

It was established, that in any medium no one investigated nano-material exists in completely free "single-nano-cluster" state. There is always equilibrium between "Reversible" aggregates and isolated nano-clusters. Equilibrium could be effectively shifted to the free isolated nano-clusters by proper choice of dispergating conditions and medium components.

Some of investigated nano-materials, co-deposited with metal layer, demonstrate sufficient improvement of plated metal quality.