

DENSE MEDIUM PLASMA SYNTHESIS OF MACROMOLECULAR STRUCTURES AND NANOPARTICLES

⁽¹⁾**Sorin Manolache** and ^(1,2)**Ferencz Denes***

⁽¹⁾*Center for Plasma-Aided Manufacturing and*
⁽²⁾*Department of Biological Systems Engineering*
University of Wisconsin, Madison WI 53706

The size-range of nano-particles is usually considered as 1 to 100 nm. This is the range where atomic and molecular interactions strongly influence the macroscopic properties of materials. In this contribution an atmospheric-pressure plasma technique, Dense Medium Plasma (DMP) environments, is described and the synthesis of organic, inorganic, and hybrid nanoparticle systems is presented.

The DMP reactor (Figure 1) is based on a digitally controlled rotating, interchangeable pin array electrode system, which due to the presence of an intense cavitation developed in the reaction media, render a volume character of the plasma processes. The plasma is generated through the liquid/vapor interphase. Both the spirally located pin array and the interchangeable metallic disk of the lower electrode

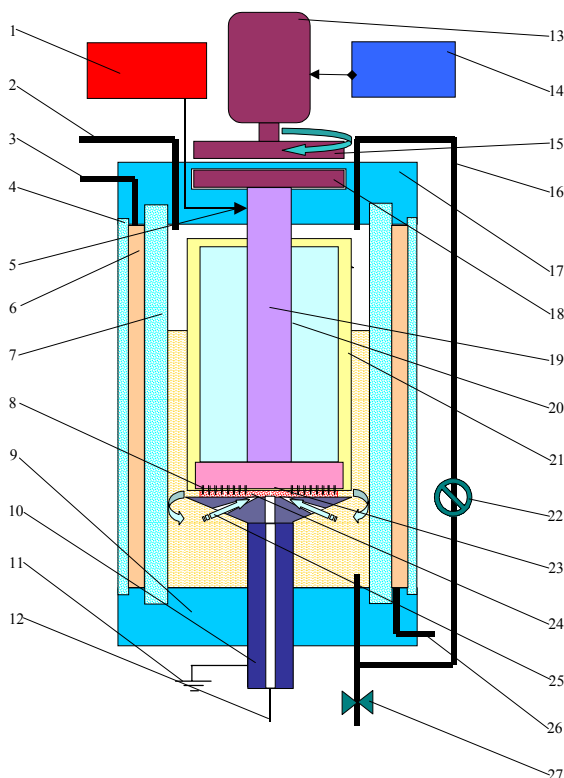


Figure 1. Scheme of dense-medium plasma reactor. 1 – DC power supply; 2 – gases evacuation; 3, 26 – coolant exit and inlet; 4, 7 – glass cylinders; 5 – electrical contact; 6 – coolant; 8 – ceramic pin-array; 9, 17 – caps; 10 – non-rotating electrode; 11 – ground; 12 – gas inlet; 13 – motor; 14 – digital controller; 15, 18 – magnetic coupling system; 16 – liquid inlet; 19 – rotating electrode; 20 – sealed volume; 21 – quartz isolator; 22 – recirculating pump; 23 – pins; 24 – electrical discharges; 25 – recirculated flux; 27 – valve.

can be made of different metals depending on the specific plasma synthesis.

Using stainless steel electrodes and benzene, toluene or xylenes as reaction medium, uniformly sized iron- and iron oxide-containing, high thermal stability (weight loss in nitrogen at 800°C is 6%), carbon-based nanoparticle systems were synthesized, which exhibit magnetic properties. Figure 2 present the typical TIC-chromatogram and identified components of the liquid phase (intermediate components) generated by DMP-synthesis on toluene media.

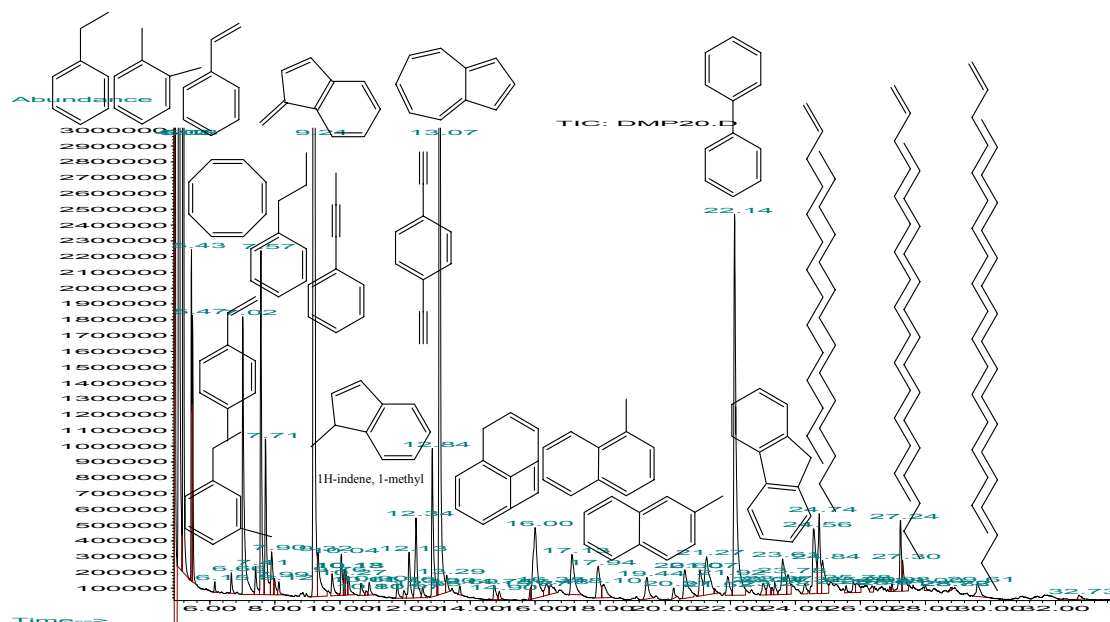


Figure 2. TIC chromatogram of liquid phase compounds synthesized from DMP-toluene system.

Starting from acrylonitrile, polyene-type structures can be generated. The LD-MS-origin fragmentation pattern of polyene-type nanoparticles shows molecular-ion fragments as large as $m/z = 700$ and a maximum in the 350-424 m/z range (approximately 30 carbon atoms connected). The pattern of MS spectra suggests the existence of an intensely dehydrogenated structure.

DMP conditions are suitable for synthesizing nanoparticles with different chemical composition and morphologies.