November 2011

As it turned out, on October 18, 2011, the European Commission (EC) adopted the Recommendation On the Definition of Nanomaterial (http://ec.europa.eu/environment/chemicals/nanotech/pdf/commission_recommendation.pdf).

In particular, the Recommendation document states that:
"….2. "Nanomaterial" means a natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50 % or more of the particles in the number size distribution, one or more external dimensions is in the size range 1 nm - 100 nm…..
3. By derogation from point 2, fullerenes, graphene flakes and single wall carbon nanotubes with one or more external dimensions below 1 nm should be considered as nanomaterials".

In actuality, for the simplest spherical molecule of fullerene (C_{60} fullerene), the "centre to centre" distance between two its opposite C atoms is 0.71 nm. If we add to this value the sum of two C atom covalent radii (i.e. 2 x 0.077 = 0.154 nm), we will obtain a size estimation for the isolated C_{60} molecule in vacuum of 0.854 nm.
OK! We could further add the so-called Van der Waals radius to the result as well. However, the latter figure will depend on those neighbour molecules that are adjacent to the fullerene molecule or in gaseous, or in liquid, or in crystalline phase. In any case, the external dimension of a C_{60} fullerene molecule still turns out to be much less than 1 nm!
The question now arises as to whether the fullerene molecules can indeed be considered nanomaterials? And, more particularly, is it reasonable to also consider individual (isolated) fullerene molecules as being some sort of (nano)materials?

If the answer to this question is YES, then, according to the aforementioned Recommendation, we must consider nanomaterials to also include a variety of objects, including biomolecules and macromolecules (DNA, RNA, proteins and enzymes, oligopeptides, oligosaccharides, lipids, etc.), which have one or more external dimensions equal to or in excess of 1 nm. Surely, if we were to follow this line, we could also draw on a lot of other examples non-biological molecules, including synthetic cage-like (carcass-like) and macrocyclic molecules of similar size, which could hardly otherwise be associated with nanomaterials.

Further, it is worth noting that a commonly used characteristic of the 'materials' (including nanomaterials) is their physical surface with its specific properties, which is clearly distinct from the properties of its constituent atoms and molecules. In contrast, contemporary science rejects "physical property" and "physical surface" concepts for an individual molecule as being meaningless – in fact, the molecule actually has nothing to do with them. This distinction is rather fundamental in nature, and it is this fact that prevents us from considering individual fullerene molecules (now available for experimentation) as nanomaterials!

Surely, we could find much support for arguments in favour of the inadequacy and irrelevance of treating free (i.e. unaggregated) fullerene molecules as nanomaterials. However, in the context of this discussion, we should also add that the above-mentioned misuse of terms arose some time ago, presumably due to the fact that fullerenes are not capable of spontaneously dissolving in water like regular sugar does, for instance. Multiple attempts to 'dissolve' fullerenes in water have invariably led to various water dispersions of hydrated micro- and nanoparticles and this fact was considered as additional support for the opinion that fullerenes constituted nanomaterials.

In general, it seems plausible that the miscorrelation of fullerenes to nanomaterials is a commonplace misconception and that this emerged, as being all the rage (‘as an attempt to follow the fashion’), in those times when the discovery of fullerenes in 1985 gave an impetus to the extensive study of nanosized objects and modern developments in the field of nanotechnology.

Some misconceptions related to fullerenes, along with the refutations thereof, are exemplified below in the P.S. section.

We conclude that molecular fullerenes must be excluded from the recommended list of nanomaterials! These are just molecules – like many other molecules, and nothing more!

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P.S. Attached below is an open letter (dated from July 2010) about what are indeed fullerenes, and what their real-life properties actually imply. This letter is addressed to many experts who have pursued, and are now pursuing, research on fullerene.

July 2011

Dear colleagues,
Dear sir/madam,

After many years of scientific research and extended preclinical and clinical trials, at the end of 2010 in Ukraine, for the first time in the world, the products "Concentrated solutions of hydrated C_{60} fullerene" (C_{60}FWS), "Water with hydrated C_{60} fullerene" and fully highly purified C_{60} fullerene were approved by the Ministry of Healthcare of Ukraine for use as a component in food products and cosmetics. This includes their administration as a multifunctional dietary supplement, which has unique medicinal and preventive properties while, at the same time, being absolutely safe for humans.

You may find this same information upon visiting our site http://www.ipacom.com, in particular via the following links:
http://www.ipacom.com/index.php/en/production-left/68
http://ipacom.com/images/Articles/annotation_en.pdf
http://www.ipacom.com/index.php/en/publications-about-c60hyfn/72
http://www.ipacom.com/images/Articles/results_trials_en.pdf

http://www.ipacom.com/index.php/en/production
http://www.ipacom.com/index.php/en/publications-about-c60hyfn/71

In addition, you may see our News and obtain the file of presentation: "About the most important **physical, chemical and biological properties of hydrated C_{60} fullerene** (C_{60}HyFn) and its water solutions (C_{60}FWS)" on our site:
http://ipacom.com/index.php/en/publications-about-c60hyfn/92

Thus, the water solutions of hydrated fullerene C_{60} have already become available commercially and they can now be purchased for further work, which provides the opportunity to:

- ascertain that, since 1995, nobody in the world has succeeded in reproducing C_{60}FWS in full, and its analogues known from the scientific literature (for example, FAS, tol-nC_{60}, etc.) have significant disadvantages in terms of their quality and purity;
- eliminate all contradictions and controversy regarding questions as to the toxicity and biological danger of C_{60} fullerene (in molecular state) once and for all;
- establish the fact of their unique and purely positive biological activity and compare them with other "fullerenes" and nanomaterials;
- understand the real reasons for the anti-oxidative action of C_{60}HyFn and other water-soluble "fullerenes";
- ascertain that C_{60}HyFn does not have pro-oxidative properties and does not stimulate the formation of powerful oxidants – singlet oxygen and superoxide-anion radicals;
- reconsider the generally accepted aberration regarding the properties of fullerenes, including statements about their high hydrophobic property;
- ascertain that fullerenes readily interact with water and that they may be dissolved in water in a molecular form;
- ascertain that C_{60}HyFn is a stable (with constant composition) highly hydrophilic complex of the C_{60} molecule with water molecules;
- determine that C_{60} molecules cannot be withdrawn from C_{60}FWS by extraction using non-polar (hydrophobic) solvents;

- ascertain that, when fullerenes form stable solutions in water, they become covered with a special hydrated shell, through which means (but not directly) they will interact with biological objects;
- understand that the testing of THF/C_{60} water dispersions is absolutely inapplicable in terms of describing the toxicological characteristics of pure fullerenes;
- understand the limited capabilities of some frequently used methods of physical, chemical and biological analysis in attempts to determine the objective characteristics of C_{60} solutions and dispersions in water, obtained according to "bottom - up" technology;
- understand that, in the case of the formation of electron donor-acceptor complexes of C_{60} with different polar molecules (e.g., H_2O, THF, NMP, Pyridine, DMSO, g-CD, Tritons, Tweens, SDS, etc.) and taking into consideration catalytic properties of the C_{60} surface itself, the properties of such complexes are not equivalent to just sum total of their components' properties;
- discover new opportunities of hydrated fullerenes' use as a tool of scientific knowledge.

We are certain that fullerenes can still offer many remarkable surprises, both in the sphere of science and in life!!!

With best wishes in your investigations!
On behalf of my colleagues,

Grigoriy Andrievsky

Director of Science, PhD.
Institute of Physiological Active Compounds, LLC.
58, Lenin ave.,
61072, Kharkov,
Ukraine
Phone: +38 057 763 0521 (Phone/Fax, Office)
+38 057 763 0336 (Lab.)
E-mail: yard@kharkov.ua or
science@ipacom.com
http://www.ipacom.com (russ./engl.)