Formation of gallium micro- and nano-spheres by ultrasonic cavitation and entrapment of organic substances within them.

Vijay Bhooshan Kumar[1], **Yuri Koltypin[1]**, Aharon Gedanken[1] and Ze'ev Porat[2,3*]

(1) Department of Chemistry, Bar-Ilan University, Ramat-Gan 52900, Israel. (2) Division of Chemistry, Nuclear Research Center-Negev, Be'er-Sheva 84190, Israel and (3) Institute of applied Research, Ben-Gurion University, Be'er-Sheva 84105 Israel.

*Corresponding authors: koltypy@mail.biu.ac.il, poratze@post.bgu.ac.il

Pure gallium has a low melting point (29.8^{o}C) and can be melted in warm water or in organic liquids, thus forming two immiscible liquid phases. Irradiation of this system with ultrasonic energy causes dispersion of the molten gallium into microscopic spheres by the process of ultrasonic cavitation. The resultant spheres were found to be in the size range of 0.2-5µm and they do not re-coalesce after the irradiation is ceased, although the ambient temperature is well above the m.p. of gallium. It was found that spheres which were formed in water are covered with crystallites of GaO(OH) (Fig. 1), whereas those formed in organic liquids (hexane and n-dodecane) are smooth, without such crystallites. However, Raman spectroscopy revealed that in organic liquids the spheres are coated with a carbon film. The GaO(OH) crystallites or the carbon film may act as the factor that prevents the re-coalescence of the spheres.

When this procedure was performed in aqueous solutions of various organic materials, such as 1, 10 phemamthroline, rather than in pure water, simultaneous formation of gallium microspheres and entrapment of some of the substrate occurred. This was evidenced by lower intensity of the absorption spectrum of the substrate after the sonication and by slow leaching of the substrate during prolonged immersion of the spheres in pure water. The leaching experiments were followed by occasional sampling of the water and recording the UV-vis spetra. It showed slow growing of the absorption curves during a period of one month (Fig. 2). We assume that the entrapped molecules are located within voids in the gallium spheres, which are partly hollow.

References

1) *Ultrasonic Cavitation of Molten Gallium: 1. Formation of micro- and nano-spheres; V. B. Kumar*, *G. Kimmel,* A. Gedanken and Z. Porat, to be published.

2) Ultrasonic Cavitation of Molten Gallium in Water: 2. Entrapment of Organic Molecules in Gallium Microspheres; V. B. Kumar, Y. Koltypin, A. Gedanken and Z. Porat, to be published.

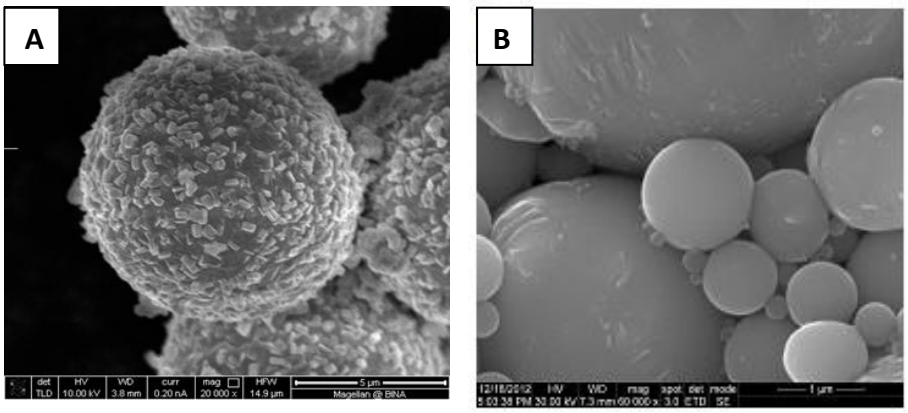

Fig. 1: SEM images of two samples, obtained after 3 min. sonication: A) A cluster of Ga spheres in water. The crystallites were identified as GaO(OH). B) A cluster of Ga spheres in dodecane.

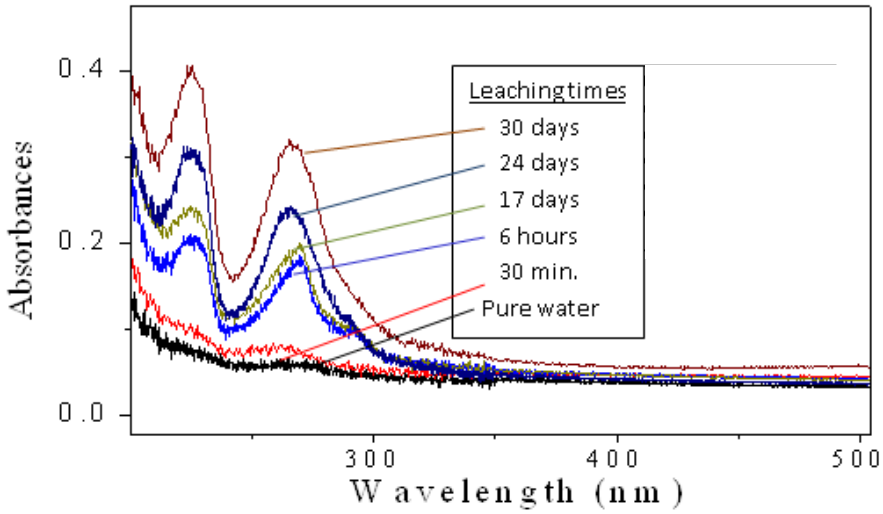

Fig. 2: UV-vis. spetra of 1, 10 phenanthroline after various leaching times. The dilution factor for all the curves is 40.