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Microencapsulation:
origin and future of the human

Most people agree that our world results from the Big Bang. The energy was spread in all directions, then concentrated in atoms, which were combined in molecules. Molecules became increasingly complex… but we still missed the principal: THE LIFE.

Allah, Yahweh, Jesus Christus and a few other gods met in brainstorming. They conclude from their discussion that developing life would need an organized structure, thus able to act against entropy, offering a protection towards various environments, enabling the creation of a system composed of 98% water and behaving as a solid, even in an aqueous medium, controlling mass and energy transfers in a very specific way, with a few more complex criteria. After a long debate, they finally arrive to the conclusion that only one system could fit with all this requirements to develop life: MICROENCAPSULATION.

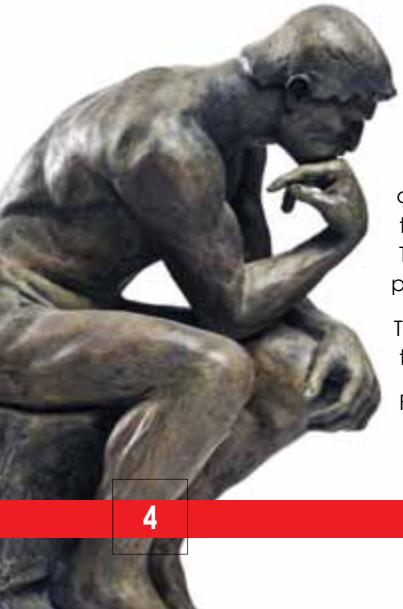
The rest of the story is well known. The first biological cell divided in two, then 4 and so on. After only 100 generations, 1030 cells were already spread first probably in the sea but they «quickly» contaminated the all Earth. Cells aggregate to give multicellular organisms, which develop to give a … HUMAN: a 10^{12} cells assembly. Life is thus strongly associated to micro-encapsulation, as much as to biochemistry.

When did humans start to develop themselves micro-capsules? As usually, everyone has his own idea, let me share mine: in 1959, a group of researchers from Dupont-Nemours published a series of papers on how to make capsules by interfacial polymerization around dispersed droplets. Since this the technology has been developed and applied for many applications: carbon less paper, slow release agrochemicals, flash release of aroma during cooking, thermoregulation using encapsulated change phase materials, intelligent textiles answering to different stimuli, yeast immobilisation for champagne or beer production, artificial organs, are only a few examples. The full list of microcapsule applications would fill several books and most of them have still to be developed.

Micro-encapsulation is already part of our daily life and in a large extend. But in most cases, microcapsules are an intermediate system in the development of the innovative product, or in the improvement of a process, and not a for-sale product. No seller will tell you that cars are cheaper and safer because screws are fixed by breaking microcapsules containing glue spread in the thread. Landry and dish machine detergents contain enzymes which are encapsulated to protect the user from adverse effects of enzymes; enzymes protect themselves from other components like peroxydes and they are released at the right time during the washing process. Today, a large part of our food is reconstituted from powder; keeping the nutritional value of ingredients requires protection against oxidization. Micro-encapsulation provides also added value to some products. Sugar companies develop the sugar coated with pectin as a single component to produce jam. We developed coated brown sugar to get free flowing powder, easy to find today on market.

An interesting aspect of encapsulation is that the number of patents is mainly twice the number of scientific publications. This shows that micro encapsulation is pulled by industry more than pushed by the academic research. Most big companies have departments developing encapsulation systems: BASF, 3M, Unilever, P&G, Nestlé, Danone, Dupont … However, micro encapsulation is a real opportunity for small and medium enterprises (Coating Place, Innovia, LC innodry, Encapsys…). Many start-ups have been successful while proposing innovative encapsulation systems emerging from academic research: Capsum, AnaBio, Capsulae, are only a few examples. The Bioencapsulation Research Group association (http://bioencapsulation.net) is counting more than 4000 contacts in industry and we do not expect to be exhaustive.

Some projects are limited to very low size production such as artificial organs development, where a few hundred grams represents the batch size. Aroma, probiotics and other nutritional ingredients encapsulation develop on markets of tens or even hundreds of kilograms, and feed market is working on the scale of hundred tons per year. Moreover, some productions such as enzyme, agrochemicals, change phase materials reach the market size of thousand tons per year.



The main challenge to be probably raised is to develop the process engineering. Many researchers from the lab scale are not realistic while envisaging a scale-up. The micro-encapsulation process is generally based on principles that do not allow large production. However, it is often at the final steps of cleaning and drying that the main problems happen. These operations may cost more than the micro encapsulation process it-self. There is then a big gap between academic research and the industrial production. Unfortunately very few pilot scale plants and research exist around the world.

The market of micro-encapsulation is still developing and will modify our life in a manner less visible than other technologies. However, its impact may be very beneficial to us.

From where do we come ... where do we go ?

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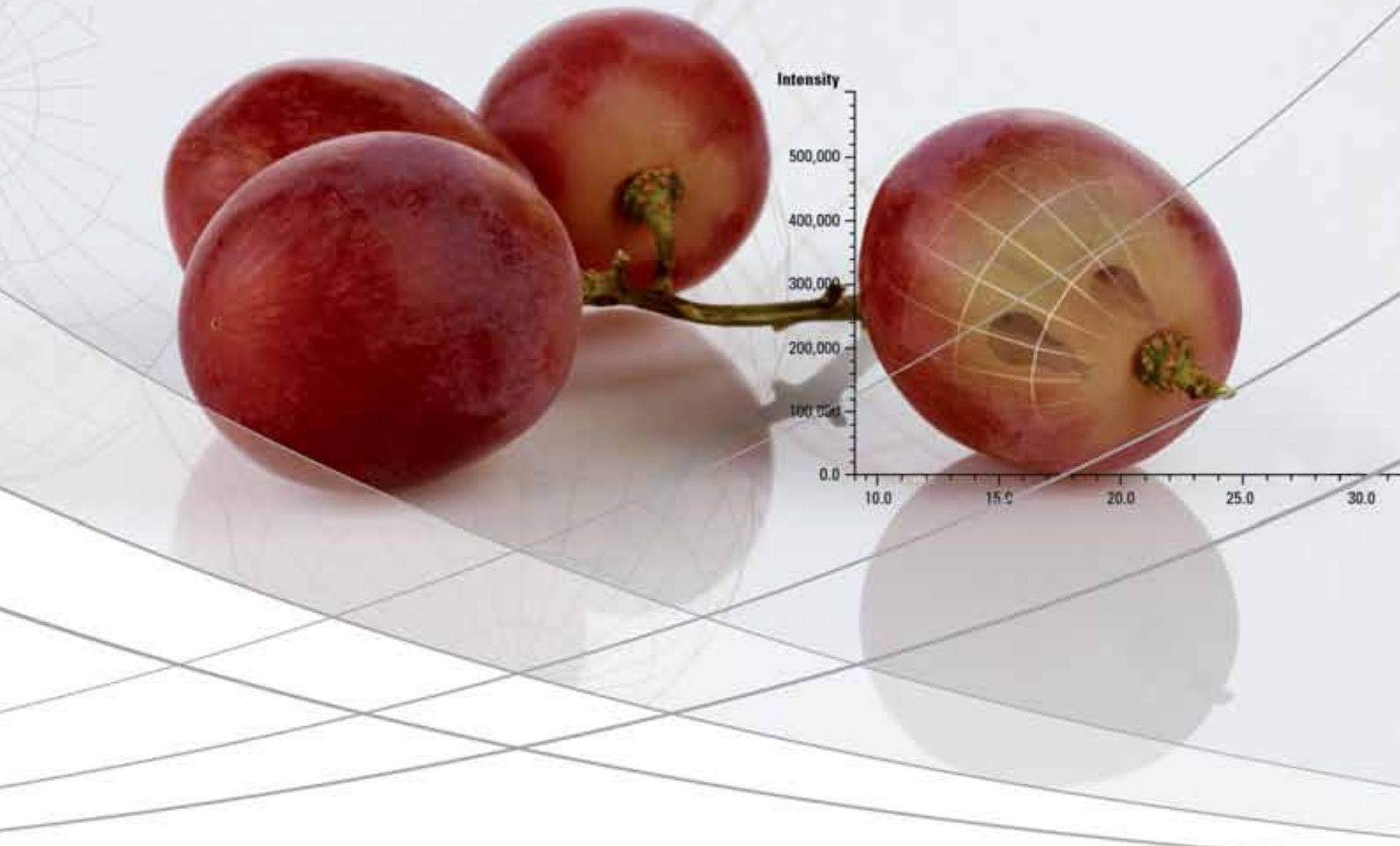

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