

Microencapsulation wall material, suspension core capsule, edible capsule with electronics, methods and a production system for producing the same

5 The present invention relates to a microencapsulation wall material of a microencapsulation product for food and beverage capsules, a suspension core capsule, a method for producing a microencapsulation wall material, a method for producing a suspension core capsule, a production system for producing a
10 suspension core capsule, and an edible capsule with electronics.

Food supplements are used to supplement the diet with vitamins, minerals, and other substances, such as long-chain fatty
15 acids, amino acids, fiber, or plant substances. They contain the nutrients in a concentrated and dosed form and are offered as capsules, powder sachets, or in similar dosage forms.

Further, the application relates to a reusable personalized
20 device using parts biodegradable and edible electronics and parts inorganic material.

Dietary supplements can contain a single nutrient or a combination of different nutrients, so-called combination products.
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Usually, the above mentioned supplements comprise sensitive matter that must be stored and handled with care which poses complex problems to manufacturers of dietary supplements who want to be able to preserve nutritional states so as to provide fresh and healthy vitamins and nutrients to the consumers.
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Currently, nutrition composition for food and beverage (including capsules) is kept in open air and exposure to environmental conditions and sunlight. They are inefficiently stored and thus subject to rapid oxidation. Several known techniques
5 have been used to store fresh produce and preserve nutritional states over time.

Refrigeration lowers ambient temperature to slow the decay of produce like berries, spinach and potatoes. However, with each
10 passing day, leafy greens like spinach lose essential nutrients like folate and vitamin C. The half-life of highly volatile nutrients in the deterioration phases of such produce is estimated to be at around 3 to 5 days.

15 As already mentioned above, the handling, storage, and preservation of food and supplements often involves changes in nutritive value, most of which are undesirable. The freezing process (pre-freezing treatments, freezing, frozen storage, and thawing), if properly conducted, is generally regarded as
20 the best method of long-term food preservation when judged on the basis of retention of sensory attributes and nutrients. The freezing process is, however, not perfect, as is apparent from the fact that substantial amounts of the more labile nutrients can be lost. Vitamin losses during freezing preservation
25 vary greatly depending on the food, the package, and the conditions of processing and storage. Losses of nutrients can result from physical separation (e.g., peeling and trimming during the pre-freezing period, or exudate loss during thawing), leaching (especially during blanching), or chemical degradation.
30 The seriousness of these losses depends on the nutrient (whether it is abundant or meagre in the average diet), and on the particular food item (whether it generally supplies a major or a minor amount of the nutrient in question). It is

estimated on average, that the half-life of nutrients in frozen food is around 14 days.

Another technique for preserving foods is canning which involves exposing foods to pressure, chemical additives, and heat. The initial encounter with heat makes the food lose nutritional value, but since cans do not have oxygen, the nutrients tend to stay where they are until the can is opened. The cooking process, however, causes further nutrient deterioration.

When drying foods for preserving them, this procedure may concentrate the fiber in plant foods to eliminate water content which can cause water-induced oxidation, reduced potency and thus, accelerate the decay of fresh produce over time. Although dried foods last longer, the process of dehydration itself, removes a great deal of vitamins, minerals, and antioxidants.

In most preservation techniques known from prior art, the nutrients are not exposed to sunlight as it adds oxidative stress to such ingredients. Exposure to sunlight (in addition to extreme heat) is likely to impact vitamin degradation such as vitamin A, B2 (riboflavin), B6, B12 and folic acid. In addition, increasing temperatures from exposure to direct heat sources like the sun harms the potency and effectiveness of a variety of vitamins and other nutrients. Degradation generally starts to occur in foods or beverages exposed to temperatures of greater than 120 °F (48 degrees Celsius). Additionally, most nutrient capsules lack the proper mechanisms to provide adequate drug releasability from the carrier.

Further in prior art, in vitro devices are known that are used for administering food and drugs. Thereby, implantable and wearable electronics are implemented as a means to monitor and administer treatment to targeted regions of interest within
5 contact. Although such devices are generally accepted as high performing monitoring and functional tools, they are often characterized by costly and invasive implantation procedures with the need for constant long-term maintenance. On the other hand, cheaper, less invasive systems are known that can be
10 worn externally. However, these external systems suffer from poor actuating and monitoring capability on organs due to electrical resistance of exposed and interstitial epidermal layers and lipids.

15 Furthermore, current in-vitro electronics are often derived from hazardous chemical reagents, solvents and adjuvants which are non-biodegradable and contribute to waste generation in its product life cycle. As a physio-chemical product, wastes are generated and accumulated across each stage of the product
20 life cycle, including its design, manufacture, use and ultimate disposal.

Considering the above, an object of the present invention is overcome the above described problems related to in-vitro and
25 externally worn electronics and, in particular, to provide an improved means for administering and monitoring foods and drugs.

Considering the above, an object of the present invention is
30 based on providing an improved and efficient way to administer and store a health supplement which further enables a timed release mechanism for releasing nutrients from an encapsulation.

A further object of the present invention is to overcome the above described problems related to in-vitro and externally worn electronics and, in particular, to provide an improved means for administering and monitoring foods and drugs.

According to a first aspect, a microencapsulation wall material of a microencapsulation product for food and beverage capsules, wherein the microencapsulation wall material comprises a hyper-polarizable hydrophilic or hydrophobic polymer species, a first mixture, wherein the first mixture comprises at least one material out of the group of collagen, chitosan, silk fibroin, gelatin, alginate, modified starch and biopolymers, and a second mixture, wherein the second mixture comprises at least one material out of the group of lecithin, cyclodextrin and whey surfactant base mixture, wherein the first mixture and the second mixture form an emulsion.

An emulsion is a finely divided mixture of two normally immiscible liquids without visible segregation. Materials of the first mixture can form particles in an emulsifier of the second mixture. The first mixture can be a W1-Phase. The second mixture can be the emulsifier. The second mixture can further be a W2-Phase. The emulsion can be a double emulsion with a type W1/O/W2. The first mixture and the second mixture can form an emulsion through emulsification.

Through this solution, a microencapsulation wall material is provided, which has improved diffusion characteristics and is edible for animals and humans.

Further, the molecules of the hydrophilic or hydrophobic polymeric species are capable of being hyper-polarized through the

application of (weakly) static and/or dynamic electromagnetic (EM) field gradients by a re-orientation of molecular dipole spins moment. The created distortion to the spherically symmetric arrangements of the electrons in the wall cytoplasm electron cloud - through the application of an EM field, causes the originally nonpolar species of hyper-polarizable hydrophilic or hydrophobic polymeric molecule or atoms to acquire a dipole moment.

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According to an embodiment, the microencapsulation wall material has an HLB value within the range of ≤ 10 .

An amphiphilic molecule is a value obtained by dividing a weight percentage of the hydrophilic part by five. There is a balance between the hydrophilic and lipophilic parts of amphiphilic molecules. This is expressed as the hydrophilic-lipophilic balance (HLB). The HLB value is an empirical scale as a measure of the HLB values of surfactants. With this, it is possible to determine an optimum range for each surface-active substance effect. A surfactant with a lower HLB has a lipophilic character. Spans, which are sorbitan esters, have lipophilic properties and low HLB values (1.8-8.6). Tweens, which are polyoxymethylene derivatives of spans, are hydrophilic and have high HLB values (9.6-16.7). To form stable emulsions, an emulsifier or emulsifier mixture having an HLB value equal to the HLB value of the oil phase should be used. This sol, a microencapsulation wall material is provided, which has lipophilic properties.

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In an example embodiment, the microencapsulation wall material has an HLB value within the range of ≥ 10

According to this solution, a microencapsulation wall material is provided, which has hydrophilic properties.

According to another embodiment, the molecules of the hyper-
5 polarizable hydrophilic or hydrophobic polymer species provided in the wall material have been processed so as to be hyper-polarized.

The wall cytoplasm - being polarized accordingly, is capable
10 of two important functions: 1) filtering harmful wavelengths of light which may pass through the polynucleated, mononucleated and matrix fill suspension, that degrade the core nutrients - encapsulated by the microencapsulated and / or nanoencapsulated shell. 2) Holding the nutrients core in place
15 within the shell by the electrostatic binding forces of the charge distorted electron cloud induced by magnetic forces. The magnetic forces inducing the charge distorted electron cloud are created by an externally applied polarized magnet to an internal nutrient core containing a ferrous epicentre mixture; including iron, magnesium, manganese, copper and zinc
20 ions.

According to a second aspect, a suspension core capsule, wherein the suspension core capsule comprises a wall comprising
25 ing microencapsulation wall material as described above and a core comprising nutrients. The wall can border the core.

Through this solution, a suspension core capsule is provided, which has specific properties to absorb the nutrients. The
30 wall controls the absorption of the nutrients.

Further, the suspension core capsule is provided with a hyper-polarizable polymeric species at the wall material, thus leveraging on a low cost and efficient mechanism of orientating the dipole spins moment, in the presence of an electromagnetic field gradient to provide superior retention of the nutrient within the encapsulated core by attraction of the nutrient to the oppositely-charged polymeric species at the inner wall of the bilayer shell. It also provides superior nutrient preservation methodologies by creating polarizing effects to sunlight - especially UV rays.

Also, this solution provides an efficient mechanism for superior nutrient releasability from the carrier by the application of a reverse electromagnetic field gradient. The deliberate release function allows for efficient (instantaneous) timed release of nutrients to be mixed with outer food and beverage suspensions for consumption. By this mechanism, the dipole spins moment of the hyper-polarizable polymeric species is realigned in the opposite direction causing a repulsion of the nutrient core to the shell. The repulsive forces between the nutrient core and the like-charged polymeric species stresses the shell surface of the micro-encapsulated and / or nano-encapsulated bi-layer to cause ruptures to the wall surface. Eventually, causing the core material to bleed out and diffuse into the external food and beverage multi-nucleated suspension core.

According to an embodiment, the wall is a bilayer wall, comprising an inner wall comprising microencapsulation wall material as described above, and an outer wall comprising microencapsulation wall material as described above.

This solution provides a wall, which has a cascaded wall, wherein the inner wall and the outer wall have different absorption properties. This allows to adjust the absorption more accurate and depending of the nutrients.

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In an example embodiment, an outside of the inner wall and an inside of the outer wall are touching each other. The inner wall can rest on the outer wall over its entire surface.

10 According to this solution an inner wall and an outer wall is provided, which are controlling the absorption. The inner wall and the outer wall form a double-walled wall, which combines the absorption properties of the inner wall and the outer wall.

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In an embodiment, the inner wall and the outer wall have a predefined thickness.

The inner wall has a predefined thickness. The outer wall has
20 a predefined thickness. The thickness of the inner wall can defer from the thickness of the outer wall.

Through this solution, an inner wall and an outer wall are provided, which have cascaded properties. Depending on the
25 thickness of each wall the absorption properties can be adjusted.

According to an embodiment, the wall comprises a timed release mechanism to release nutrients.

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This solution provides a wall, which absorbs the nutrients over time. This improves the intake of the nutrients of the

human body. This allows the delivery of the nutrients in a course of time.

According to a further embodiment, the capsule comprises a
5 ferrous nutrient core. Preferably, the ferrous nutrient core is positively charged.

According to another embodiment, the ferrous nutrient core comprises iron, magnesium, manganese, copper and zinc ions.
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According to still another embodiment, the hyper-polarizable hydrophilic or hydrophobic polymer species is arranged radially inside and outside the inner wall.

15 According to an alternative embodiment, the hyper-polarizable hydrophilic or hydrophobic polymer species is arranged radially at the outer wall.

Preferably, the hyper-polarizable hydrophilic or hydrophobic
20 polymer species molecules have been treated so as to be hyper-polarized.

According to still another embodiment, the capsule further comprises a neutrally charged membrane arranged radially at
25 the outer surface of the microencapsulated bilayer wall. The neutrally charged membrane may comprise lipid-like chain segments. The lipid-like chain segments may be arranged radially at the outer surface of the microencapsulated and nanoencapsulated bilayer wall in order to prevent the attraction and ad-
30 hesion of impurities at the microencapsulated shell surface.

According to a third aspect, a method for producing a microencapsulation wall material comprises in a first step providing

a first mixture, wherein the first mixture comprises at least one material out of the group of collagen, chitosan, silk fibroin, gelatin, alginate, modified starch, and biopolymers and in a further step providing a second mixture, wherein the second mixture comprises at least one material out of the group of lecithin, cyclodextrin, and whey surfactant base mixture, and forming an emulsion with the first mixture and the second mixture, wherein the wall material comprises a hyper-polarizable hydrophilic or hydrophobic polymer species.

According to one of the examples above, the method can be performed in a single flow.

Through this solution, a method is provided, which improves the producing process of the microencapsulation wall material. This leads to cheaper and more effective production.

The above method can be used for efficiently protecting volatile nutrient compounds such as vitamins, minerals, antioxidants, amino acids, sericin and fibroin extracts from the effects of oxidation by exposure to direct and indirect sunlight. The protection mechanism relies on the reversible orientation of the hyper-polarizable polymeric species dipole spins moment, in the presence of an electromagnetic field gradient. This creates two effects. 1) An attraction of the nutrient core to the inner wall material of the micro-/nano-capsule and 2) creating a polarizing effect to filter out partially or completely, the full wavelengths of sunlight.

Additionally, the above method may also be used for the deliberate release of volatile nutrient compounds entrapped within the microencapsulated and / or nanoencapsulated wall material to be mixed with the outer food and beverage multi-nucleated

core suspension for consumption. The deliberate release function relies on the reversible orientation of the hyper-polarizable polymeric species dipole spins moment, in the presence of an reverse electromagnetic field gradient to create two effects. 1) A repulsion of the nutrient core from the inner wall material of the micro-/nano-capsule, thereby creating lesions on the surface of the microencapsulated and/or nanoencapsulated shell through stress and eventually breaking or bursting the microencapsulation and/or nanoencapsulation wall structure. 2) creating a depolarizing effect to light waves, so that sunlight may pass through and the core becomes visible. However, this effect may be redundant since the contents of the microcapsules have already been released into and mixed with the outer multi-nucleated core suspension.

Summarizing the above, the inventive method enables the creation of efficient storage and timed release mechanisms of multi-nucleated suspension cores for fresh and optimally therapeutic consumption of vitamins and nutrients at efficient resources and low costs.

According to an embodiment, the method is further comprising a step of atomizing the emulsion into vapor microparticles. The vapor microparticles can be vapor nanoparticles.

Through this solution, a method is provided to produce vapor microparticles, which further improve the properties of the wall material and simplify the production process.

According to an embodiment, the method is further comprising a step of providing a homogenizer.

Through this solution, a method is provided, which homogenizes the particles. Related to the homogenization the wall material can be produced with more uniform properties.

- 5 The above-described embodiments of the method are particularly suitable to produce a wall material according to one of the above-described embodiments of the wall material.

10 According to a fourth aspect, a method for producing a suspension core capsule comprising the method steps of the method described above and further comprising the method steps of providing a core comprising nutrients, providing a microencapsulated wall material, and encapsulating the microencapsulated wall material around the core.

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The above-described embodiment of the method is particularly suitable to produce a suspension core capsule according to one of the above-described embodiments of the suspension core capsule.

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Through this solution, a method for producing a suspension core capsule is provided, which improves and simplifies the production process of the suspension core capsule. This solution reduces the production costs and increases the production efficiency.

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30 According to an embodiment, the method further comprises a step of applying a static and/or dynamic electromagnetic field gradients to the suspension core capsule, in particular, applying a magnetic north polarity to the suspension core capsule by an externally applied polarized magnet at opposing

ends of a circular profile of the wall material, thereby inducing a dipole moment in the molecules or atoms of the hyperpolarizable hydrophilic or hydrophobic polymeric species.

5 According to a further embodiment, the method further comprising a step of applying a reversed magnetic south polarity to the suspension core capsule by an externally applied polarized magnet at opposing ends of a circular profile of the wall material, thereby causing the molecules or atoms of the hyperpolarizable hydrophilic or hydrophobic polymeric species to
10 reverse the orientation of their dipole spins moment.

According to a fifth aspect, a production system for producing a suspension core capsule, as described above, comprises a homogenizer, an atomizer, an emulsification bath, a spray nozzle, mixer, a spray chamber, a cooker, a holding tank, a dispersion system, and an encapsulation machine, wherein the system is configured to carry out a method as described above.
Through this solution, is provided, which is

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The above-described embodiment of the production system is particularly suitable to carry out a method for producing a microencapsulation wall material and a method for producing a suspension core capsule as described above.

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The above-described embodiment of the production system is further particularly suitable to produce a microencapsulation wall material and a suspension core capsule as described above.

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Through this solution, a production system is provided, which reduces the costs and improves reliability.

According to a further embodiment provided is an edible capsule, comprising

a wall comprising microencapsulation wall material according to the invention described above, forming a core, and an
5 electronic component included in the core, wherein the wall is a bilayer wall, comprising an inner wall comprising microencapsulation wall material according to claim 1 to 4, and an outer wall comprising microencapsulation wall material according to the invention described above.

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The electronic component may be comprised of biodegradable, edible parts.

Hereby, the electronic component may be located on the surface
15 of the inner wall.

In one alternative, the electronic component comprises a wireless sensor for sensing data and a wireless transceiver and for communicating the sensed data to a receiver. For complex
20 computational tasks, a low powered computer processing unit (CPU) chip may also be embedded.

In a further alternative, the capsule further comprises an electrolytic power source charging circuit and a magnetic polarity inducer for charging potentials of electrolytic power
25 sources embedded within the edible capsule.

The electrolytic power source may be embedded at the outer wall of the core.

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The electronic component of the edible capsule may serve for at least one of product tagging, quality control, targeted release mechanisms, GI tract physiological monitoring, nutrient therapeutics, pharmaceutical drug administration.

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The invention further provides a method of producing an edible capsule as described above, comprising

- Stacking several predetermined layers on top of one another, the topmost first layer being a biodegradable predominant hydrophobic imprinting substrate for receiving electrical circuitry of the electrical component,
- 10 the second layer beneath the first layer being a hydrophilic sacrificial layer, which is adapted to dissolve in contact with water,
- 15 the third layer beneath the second layer being a porous hydrophobic water insolvent substrate, which is adapted to act as a flat stable backing for laminating and circuitry imprinting, forming organic field effect transistors through vapour deposition through atomization nozzle,
- 20 forming, on the first layer, a metal ion strip connected to the organic field effect transistors,
- placing, onto the first layer, a silicon dioxide food grade substrate comprising organic solar cells formed by spin coating onto the silicon substrate,
- 25 stacking on top of the metal ion strip and the solar cells a further organic layer to form an additional electric circuit imprinting substrate,
- vapour-depositing further electronic circuitry onto the further organic layer,
- 30 thus obtaining a laminating substrate,
- inverting the layer laminating substrate to orient the circuitry facing downwards and bringing the inverted laminating layer in direct contact with the capsule wall surface,

dripping water droplets onto the third layer, the third layer letting the droplets pass to the second layer, thus dissolving and bio-degrading the hydrophilic second layer into edible derivatives which are safe for consumption,

5 sliding off the third layer, and bringing the laminating substrate including the first layer with the imprinted embedded electronic circuitry in direct contact with the inner wall of the encapsulated suspension core capsule produced with the method as described above,

10 covering the circuitry by the outer wall produced with the method of as described above.

The laminating layer may be ionically or covalently bonded to the inner surface of the inner wall.

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The invention further provides a non-biodegradable capsule suspension housing comprising electronic circuitry being fabricated with embedded non-organic electronics,

20 the circuitry being adapted to act as a magnetic power source for power transference to charge an (organic) electrolyte battery supply when the capsule as described above is docked into the housing.

25 Embodiments of the application will now be described with reference to the attached drawings.

Fig. 1 shows a section view of a suspension core capsule that contains a multi-nucleated food and beverage extract core,

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Fig. 2a shows a section view of a suspension core capsule with multi-nucleated nutrient core in a liquid meta-core suspension,

Fig. 2b shows a section view of a suspension core capsule with multi-nucleated nutrient core in a solid meta-core suspension,

5 Fig. 3 shows a flow chart for manufacturing a suspension core capsule,

Fig. 4 schematically shows an embodiment of a finished suspension core capsule under the influence of an external magnetic
10 field,

Fig. 5 schematically shows the finished suspension core capsule under the influence of a reverse external magnetic field,

15 Fig. 6 schematically shows another embodiment of a finished suspension core capsule,

Fig. 7 shows a conceptualized finished edible electronics micro / nano encapsulation wall material product, and
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Fig. 8 shows a conceptualized process for laminating edible circuitry onto the exposed inner surface of the bi-layered micro / nano encapsulated suspension core encapsulation wall.

25 Fig. 1 shows a section view of a suspension core capsule 1 that contains a multi-nucleated food and beverage extract core 21. The multi-nucleated food and beverage extract core 21 is also called multi-nucleates nutrient core 21.

30 The suspension core capsule 1 comprises a microencapsulation wall 10. The microencapsulation wall 10 can be single or double-walled. In case the microencapsulation wall 10 is double-

walled and outside of the inner wall and an inside of the outer wall are touching each other, over a whole surface.

The microencapsulation wall 10 includes or comprises a meta-
5 core suspension 20. The meta-core suspension 20 can be liquid or solid.

In the meta-core suspension 20 are multi-nucleates nutrient core 21 arranged. The multi-nucleates nutrient core 21 can
10 comprise an additional wall. The microencapsulation wall 10 can be single or double-walled.

The microencapsulation wall material, the microencapsulation wall 10 is made, is composed of a large galantine mix. The
15 galantine mix serves to protect the multi-nucleates nutrient core 21 and the meta-core suspension 20 from the process of oxidation. It can be single-walled and can contain a matrix of suspended solids.

20 The multi-nucleates nutrient core 21 is the highly volatile microencapsulated and/or nanoencapsulated vitamin and nutrient core. Multi-nucleates nutrient core 21 delivers nutraceuticals and flavonoids to the consumer upon consumption of the suspension core capsule 1.

25 The microencapsulation wall 10 provides for the protection of degradation and reaction with the outer food and beverage core extract 21 within the suspension core capsule 1. The microencapsulation wall 10 can be single or double walled and pro-
30 tects against UV oxidation.

The multi-nucleates nutrient core 21 in the meta-core suspension 20 can contain reactants and/or adjuvants to accelerate

and assist in the nutrient delivery process and timed mechanisms of vitamin absorption.

The meta-core suspension 20 provides a medium of suspending
5 single and multi-nucleated nutrient core particles 21 in a liquid and/or emulsifying matrix. The emulsifying matrix will react with either temperature, pressure, or dilution upon breakage of the microencapsulation wall material to produce a water-based liquid slurry in oil or vice versa. The microen-
10 capsulation wall material is palatable for the consumption of a healthy, food and/or beverage product. Food and/or beverage product are filled with nutrients and added vitamins and minerals to promote convenient and healthy diets.

15 Fig. 2a shows a section view of a suspension core capsule 1, as described in Fig. 1, with multi-nucleated nutrient core 21 in a liquid meta-core suspension 20.

The microencapsulation wall 10 can comprise an inner wall and
20 an outer wall. The inner wall can comprise an inner wall matrix 11.

The microencapsulation inner wall material of the suspension core capsule 1 can be a double layer matrix that is immiscible
25 with each other. The double layer matrix acts as barriers to external reactants and diffusers. Furthermore, the meta-core suspension 20 of the suspension core capsule 1 can be a liquid.

30 Fig. 2b shows a section view of a suspension core capsule 1, as shown in Fig. 2a, with multi-nucleated nutrient core 21 in a solid meta-core suspension 20.

The suspension core capsule 1 comprises a solid meta-core suspension 20 instead of a liquid meta-core suspension 20, as shown in Fig. 2a.

5 Fig. 3 shows a flow chart for manufacturing a suspension core capsule 1.

The system process for manufacturing the suspension core capsule 1 can be a single flow process from the filling of active
10 ingredients to the encapsulation of the multi-nucleated core 21.

The system process starts with the active ingredients packed into canisters for filling into a feed composite mixture. The
15 active ingredients may be contained in the canisters as powdered, liquid, or hybrid material phases.

From the active ingredient canisters, the feed material is dispensed into a filler in a method step S1. The filler separates
20 the feed material and controls the rate at which the active ingredients are dispensed to the feeder in a method step S2a. In this step, the active ingredients are environmentally measured, maintained, and stored in holding containments in preparation for the next step of processing.

25 In the next step, an intelligent feeder collects mixtures of the active ingredients and prepares them for homogenization in a method step S3a. At this step, impurities and concentrations are tested to verify and ensure that correct chemical balances
30 are reached and maintained.

The feeder provides a feedback loop through a collection of sensor and machine data to inform the filler of the necessary

control parameters to tune when dispensing the active ingredients in a method step S2b.

These parameters may include the rate of active ingredient
5 dispense, flow, temperature, humidity, etc.

The next step is where ingredients are homogenized by batches in classes. Different classes of homogenization from the feed ingredients are stored in the apparatus in this step.
10

The homogenizer actuates the homogenization process through a variety of methods, e.g., high pressure, energy dispersion, turbulent dissipation, cavitation, etc. It also contains an intelligent feedback system to control the feeder operating
15 parameters in real-time in a method step S3b.

The next step is the emulsifier which adds in the surfactants and the core multi-nucleated nutrient/vitamin of the product in a method step S4a. In this step, the emulsification is performed through the effect of high energy homogenization on the
20 active ingredients, the core capsule suspension 20, and the emulsifying agents. This step also includes an intelligent feedback sensor to the feeder in a method step S4b.

25 In the next step, an atomizer atomizes the completed emulsion from the previous steps into vapor nanoparticles and microparticles of similar sizes in a method step S5a. The atomizer contains an intelligent feedback loop to the homogenizer based on sensor and machinery data to control, the operational behavior and parameters of the homogenizer during and before the
30 emulsification process in a method step S5b.

After spray drying, the double and singled walled matrix microcapsules and nanoparticles produced from the spray dryer process are collected via a canonical cyclone drum. They are loaded into the food and beverage suspension via a vibrational
5 sifter in a method step S6a. The spray dryer includes an intelligent feedback system that feeds sensor and machine data back to the emulsification module to automate the control of the spray dryer operational parameters in a method step S6b.

10 As a next step, a homogenization process takes place in a method step S7. In this step, nanoparticles and microparticles from different spray drying processes containing different nutrient and/or vitamin core multi-nucleates 21 are loaded into the baseline food and beverage liquid / semi-liquid core. The
15 process at this step involves low energy dissipation agitative components to homogenize the meta-core suspension 20.

The meta-core suspension 20 is then loaded into the hopper of a standard soft/hard gel encapsulation machine in a method
20 step S8a. The standard mixture will include the feed and a galantine-based call coating which is weaved into the die-cutting rollers of the machine. The encapsulation contains an intelligent sensing feedback loop that automates control of the spray dryer for operational parameterization in a method step
25 S8b. The product as described in Fig. 1 is then produced from this highly structured, systemic manufacturing process in a method step S9.

In an embodiment, the microencapsulation wall material borders
30 a core and protects the core against UV oxidation.

In an embodiment, the microencapsulation wall 10 has an ellipsoid, spherocylindrical, spherical, oval, oblong, and/or tubular shape.

5 Fig. 4 schematically shows an embodiment of a finished suspension core capsule 1 under the influence of an external magnetic field. In particular, the finished hyper-polarizable micro-/nanoencapsulation wall material forming the microencapsulation wall is shown with a distorted electron cloud 22 under
10 the influence of an external magnetic field. Basically, the configuration of the suspension core capsule 1 corresponds to the one shown in Fig. 1, with a single or double-layered wall 10, surrounding a multi-nucleates multi-nutrient core 21 in a meta-core suspension 20 that can be liquid or solid. One of
15 the nucleates is represented at larger scale. Namely, as can be seen in the enlarged detail of a nucleate from the multi-nutrient core 21, the nucleate also is enclosed by a microencapsulation wall 10 which may be single or double-walled, as described with respect to Fig. 1.

20 As can be seen here, the reference numeral 23 indicates an externally applied magnetic north polarity N on the capsule 1 at opposing ends of the circular profile of the wall material of the microencapsulation wall 10.

25 The applied magnetic polarity N, indicated by reference numeral 23, causes the molecules or atoms of the hyper-polarizable polymeric species comprised in the microencapsulation wall 10 to reorient their dipole spins moment to the distorted
30 electron cloud 22. The distorted electron cloud 22 is formed with the positive polarity of the polymeric species arranged radially at the outer surface 24 of the inner bilayer wall 25

and correspondingly with the negative polarity of the polymeric species arranged radially at the inner surface 26 of the inner bilayer wall 25 of the microencapsulation wall 10.

- 5 Inside the microencapsulation wall 10, a positively charged ferrous nutrient core 27 is arranged, wherein which, the positive charges are attracted to the negative radially charged inner bilayer wall 25 of the microencapsulation wall 10.
- 10 The interface 28 between the positively charged ferrous nutrient core 27 and the negatively charged inner bilayer capsule wall surface 26 creates an interstitial adhesion between the nutrient core 27 and the polymeric species inner bilayer wall 25. This electrostatic adhesion at the interface 28 will be
- 15 able to hold the nutrient core 27 in place.

Due to the distorted electron cloud indicated by reference numeral 22, the polymeric species will have a net orientation indicated by the double arrows, reference numeral 29, by means

20 of which it serves as a radially polarizing filter to block out one or two planes of vibration from electromagnetic light sources (e.g. sunlight).

In Fig. 4, the incident non-polarized light, indicated by reference numeral 30, is conceptualized to have been reflected at

25 a 90-degree scattering angle, wherein the reflected light is indicated by reference numeral 31, to completely filter out light incident to the ferrous nutrient core 27 to produce the polarized light 31 that is reflected away from the outer surface 32 of the microencapsulation wall 10.

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Fig. 5 schematically shows the finished suspension core capsule 1 under the influence of a reverse external magnetic field. In particular, Fig. 5 shows the finished product comprising the hyper-polarizable micro-/nanoencapsulation wall material 10 and a distorted electron cloud 22 under the influence of a reverse external magnetic field 23'.

The reference numeral 23 now indicates the externally applied reversed magnetic south polarity S on the capsule 1 at opposing ends of the circular profile of the wall material 10.

The applied magnetic polarity 23 causes the molecules or atoms of the hyper-polarizable polymeric species to reverse the orientation 29 of their dipole spins moment to the distorted electron cloud 22. The distorted electron cloud 22 is formed with the negative polarity of the polymeric species arranged radially at the outer surface 24 of the inner bilayer wall 25 and correspondingly with the positive polarity of the polymeric species arranged radially at the inner surface 26 of the inner bilayer wall 25 of the microencapsulation wall 10.

The material of the microencapsulation wall 10 retains a positively charged ferrous nutrient core 27, wherein which the positive charges are repelled from the positively radially charged inner wall 25 of the microencapsulation wall 10.

The interface 28 between the positively charged ferrous nutrient core 27 and the positively charged inner surface 26 of the inner bilayer wall 25 creates an interstitial repulsion between the positively charged ferrous nutrient core 27 and the polymeric species comprised in the inner bilayer wall 25. This electrostatic repulsive force at the interface 28 will cause dynamic exogenous stresses to the microencapsulation wall 10,

eventually resulting in lesions and / or ruptures to the surface 32 of the shell or microencapsulation wall 10.

Due to the distorted electron cloud 22, the polymeric species
5 will have a net orientation indicated by the double arrows indicated by reference numeral 29 wherein which it serves as a radially de-polarizing filter to allow all planes of vibration from electromagnetic light sources (e.g. sunlight).

10 In Fig. 5, the incident unpolarised light indicated by reference numeral 30 is conceptualized to have been reflected at an angle of 180-degree (0 radians) scattering angle to completely pass through incident to the ferrous nutrient core 27 to produce the polarized light 34.

15

Fig. 6 schematically shows another embodiment of a finished suspension core capsule 1 with two enlarged details of the microencapsulation wall 10 surrounding the multi-nucleates multi-nutrients core 21.

20

The wall coating of the macrocapsule 1 may be double layered to provide for an additional protection mechanism similar as the one provided to the microencapsulated volatile nutrients and vitamins against UV oxidation and degradation. For example,
25 ple, the wall material of the microencapsulation wall 10 of the macrocapsules may be provided as a double layer comprising the hyper-polarizable polymeric species which is immersible with each other and act as an optical barrier to sunlight due to the polarizing effects described with respect to Fig. 4 and
30 Fig. 5 and as a mechanical and chemical barrier with respect to impurities.

Furthermore, the inner core matrix of the macrocapsules may be a solid suspension, as shown in the embodiment of Fig. 2b.

The following items are also comprised by the present invention:
5 tion:

A microencapsulation wall material of a microencapsulation product for food and beverage capsules, wherein the microencapsulation wall material comprises

- 10 - a first mixture, wherein the first mixture comprises at least one material out of the group of collagens, chitosan, silk fibroin, gelatin, alginate, modified starch, and biopolymers, and
- a second mixture, wherein the second mixture comprises at least one material out of the group of a
15 lecithin, cyclodextrin and whey surfactant base mixture,
 wherein the first mixture and the second mixture form an emulsion.

20

According to a further item, a suspension core capsule is provided, wherein the suspension core capsule comprises a wall comprising microencapsulation wall material comprising

- a first mixture, wherein the first mixture comprises
25 at least one material out of the group of collagens, chitosan, silk fibroin, gelatin, alginate, modified starch, and biopolymers, and
- a second mixture, wherein the second mixture comprises at least one material out of the group of a
30 lecithin, cyclodextrin and whey surfactant base mixture, wherein the first mixture and the second mixture form an emulsion

and a core comprising nutrients.

According to a further item, a method for producing a microencapsulation wall material is provided, wherein the method comprises the following steps:

- providing a first mixture, wherein the first mixture comprises at least one material out of the group of collagens, chitosan, silk fibroin, gelatin, alginate, modified starch, and biopolymers,
- providing a second mixture, wherein the second mixture comprises at least one material out of the group of a lecithin, cyclodextrin and whey surfactant base mixture, and
- forming an emulsion with the first mixture and the second mixture.

According to still a further item, a method for producing a suspension core capsule comprising the method steps of the method outlined above is provided, and further comprising the method steps of:

- providing a ferrous core,
- providing a microencapsulated wall material, and encapsulating the microencapsulated wall material around the nutrient core.

25

According to still a further item, a production system for producing a suspension core capsule is provided, wherein the production system comprises a homogenizer, an atomizer, an emulsification bath, a spray nozzle, mixer, a spray chamber, a cooker, a holding tank, a dispersion system, and an encapsulation machine, wherein the system is configured to carry out a method outlined above.

In a yet further embodiment of the invention, described in connection with Fig. 7 and Fig. 8, the above described capsule bi-layer wall surface material, encapsulating the polarized micro encapsulated suspension core is fabricated with micro
5 and / or nano scale organic field effect transistors, (organic) diodes, (organic) capacitors, (organic) inductors, (organic) electrodes and (organic) resistors which are connected together through printed etches of vapour deposits of charged organic (metal) ions as path of least resistances for electrical
10 discharge between a potential difference from an organic energy source like the electrolyte batteries, organic capacitors and / or inductors. Our invention utilizes the sheet like surface-engineered substrate (e.g. alginate, chitosan, lecithin, gelatine, gluten and protein etc.) sheet bi-layer mixture - forming the wall material as a simple and versatile
15 platform for the integration of soft biodegradable electronics with our food and beverage microcapsule suspensions.

An electrical circuit of configuration A, coupled with edible
20 sensors and (edible) low frequency transceivers (including passive wire antennas) enable the accurate tracking, identification and quality / degradation monitoring of micro encapsulated food and beverages described above during preparation, delivery and stocking - without having to expose the internal
25 contents from external wrapping and sealants.

Alternatively, this electrical circuit configuration may be reversed (configuration B), with the electrical circuit forming two coils around a connected reluctance within the bi-
30 layer surface of the encapsulation membrane to induce a weak magnetic field for locale specific release of nutrients and drugs to administer non-invasive biomedical and nutrient ther-

apy at targeted physiological regions within the body (primarily from the GI tract). The controlled release of micronutrients, drugs and medicine (as alternative medical applications) encapsulated within the microcapsules of the suspended core
5 will occur via the same mechanisms as detailed under the influence of an applied EM field gradient.

Alternatively, an ethylcellulose layer may be fabricated and printed with micro and / or nano circuitry containing organic
10 electronic components (e.g. Organic FETs, diodes, capacitors, inductors, electrodes, etc.) and transferred via wet press drying onto the surface of the wall material containing the microencapsulated suspension core. Additionally, for nano soft electronics, the same ethylcellulose layer may also be used
15 and press dried onto the "sandwiched" bi-layer surface of the double walled microcapsules.

These embodiments fulfil the needs in two general categories of edible electronics applications.

20

The first category of application addresses clinical tasks within the biomedical and pharmaceutical arena. With electronic circuitry of configuration A, and a combination of biodegradable and biocompatible polymers (e.g. cellulose-based
25 parkesine celluloid, cellophane, casein delivered galalith bioplastics, etc.). Our invention fulfils the need for health status monitoring of at-risk individuals from within the GI tract. A significant number of critical biomedical tasks also fall under this application purview - ranging from diagnostics
30 and point of care testing to therapy and controlled drug delivery. Our invention allows intelligent electronics to be consumed in the form of a "smart pill" which addresses the

need for digital monitoring of medicine intake in the context of chronically treated conditions.

For example, edible electronics devices can be adapted for
5 rapid and precise detection of gastrointestinal bleeding or
diagnostics of steatorrhea through monitoring of fat acids in
the lower GI tracts. A range of pathologies and disorders of
the GI system can also be monitored by sensing the essential
physical and chemical parameters of GI environments like pH,
10 temperature, or peristalsis. Electronics with novel and unique
capability of being safely ingested and metabolized can be
consumed by patients on a daily base, along with pills or even
food. Eliminating the need of device recollection and, conse-
quently, hospitalization, data on the patients' health would
15 be transmitted in real time to healthcare professionals.

The second category of application tackles nutraceuticals, nu-
trient delivery and therapy in the food and beverage industry.
Particularly, when dealing with the category of the devices
20 operating outside the body. In this context, identification
(ID) "smart" edible electronics labels integrated with the mi-
cro foods and beverage capsules can represent a sensing solu-
tion against fraud and counterfeit nutrient enriched consuma-
ble products or provide the control of the vitamin and miner-
25 als exposure to harmful external conditions like UV, tempera-
ture, and humidity. The concept of edible electronics implies
that the ID "smart" label can be consumed along with the
nutraceutical / nutrient enriched food and beverage capsule
without the need to be removed before administration. The
30 electronics then degrades into harmless composites during in-
gestion, after a temporal operational time window within the
human body. Additionally, our invention enables monitoring and

tracking of quality of microencapsulated food and beverages (especially perishable cases) along the distribution chain.

These embodiments enable cheap "smart" consumable tags to be
5 embedded into our encapsulated bi-layer wall surface as a direct contact mechanism with our micro food and beverage products, additionally eliminating the need for extra label packaging. The introduction of such "smart" tags from our inventive concepts can improve the quality control in terms of
10 traceability, contaminants and chemicals analysis, healthiness and safety regulation, leading at the same time to a reduction of food waste and limiting the use of toxic packaging with bulky and poorly informative labels. Serving public health, our invention can also control the state of the product and
15 communicate its condition to the user in real time. The spectrum of food and beverage monitoring systems is potentially wide ranging, from relatively simple and qualitative temperature-time indicators to sophisticated and quantitative sensors controlled by lightweight CPU chipsets for detection of pesticides, antibiotics, bacteria, and biogenic amines.
20

Current in vitro devices considered for food and drug administration leverage on implantable and wearable electronics as a means to monitor and administer treatment to targeted regions of interest within contact. Although such devices are
25 generally accepted as high performing monitoring and functional tools, they are often characterized by costly and invasive implantation procedures with the need for constant long-term maintenance. Additionally, cheaper, less invasive systems
30 that can be worn externally suffer from poor actuating and monitoring capability on organs due to electrical resistance of exposed and interstitial epidermal layers and lipids.

Furthermore, current in-vitro electronics are often derived from hazardous chemical reagents, solvents and adjuvants which are non-biodegradable and contribute to waste generation in its product life cycle. As a physio-chemical product, wastes
5 are generated and accumulated across each stage of the product life cycle, including its design, manufacture, use and ultimate disposal.

The inventive concept of ingestible electronics embedded into
10 the microcapsule suspension bi-layered wall surface focuses on innovative circuit design by exploiting electro-chemical properties of novel bio-degradable packaging systems described above for sensing and telecommunication applications. Ingestible electronics trade non-invasive functionalities (e.g. food,
15 drug and nutrient therapeutic administration, sensing and communication) for temporal contact time windows with the body - providing for efficient electronic operations at the gastrointestinal (GI) digestive tract level during this period.

20 The materials as described above are used as packaging material for imprinting circuit and electronics to provide for autonomous and semi-autonomous monitoring, treatment and administration of nutrients in the GI tract. Instead of relying on rigid, impervious polymers and polycarbonates as electronic
25 circuit imprinting substrates, functionally designed and imprinted electro-static potentials as fundamental electronic building blocks to more sophisticated electrical circuits are maintained and switched in vitro from charged ions within the bio-degradable capsule as it travels down the GI tract during
30 ingestion.

This embodiment of the invention covers possible applications from unsupervised administration as over the counter medicine

and nutraceuticals to the smart tagging of food and beverages for nutrient therapy while outweighing risks over benefits of micro foods and beverages consumption.

- 5 Fig. 7 shows a conceptualized finished edible electronics micro / nano encapsulation wall material product and various circuit configurations for different food, beverage, nutraceuticals, pharmaceuticals and medical applications.
- 10 ξ denotes the part reusable non biodegradable micro and nano capsule suspension housing that is designed and fabricated with embedded non-organic electronics (e.g. silicon). α denotes the battery. β , Σ , γ , δ are the capacitor, inductor, transistor and resistor respectively. η denotes the high
- 15 switching voltage regulator, ε denotes the electro-magnetic transformer substrate from "n" turns Σ inductor coils. μ denotes the alternating magnetic field induced electrical coil with "m" turns.
- 20 This circuit configuration acts as a hard wired alternating magnetic power source for power transference to a receiver for the purposes of charging an (organic) electrolyte battery supply when the microcapsule suspension core is docked into the housing.
- 25 The micro / nano suspension encapsulated core, Φ has been elaborated above and remains largely unchanged in this design, except that organic and inexpensive circuitry forming functional edible electronics has been ingrained and embedded into
- 30 a biodegradable substrate and bio-chemically fused onto the surface of the inner bi-layer capsule wall.

Config A (configuration A) of edible electronics is the first pre-conceived configuration for a wireless transceiver for smart sensor data. It functions to address requirements for food and beverage tagging, physiological monitoring, quality control and controlled release of nutrients, drugs and medication for targeted therapeutic and medical purposes.

In Config A, ρ denotes the wireless antenna, τ denotes the diode, π denotes the (ultra-high) speed switching diode at the transceiver end. At the sensing end, Ω denotes the electrolytic sensor, Θ denotes the sensing frequency switch. This configuration enables the sensor to immediately send data to the hard receiver (not drawn) in the physical non-biodegradable housing for feedback displays of sensor information (e.g. temperature, humidity, PH levels, proximity, inertia, etc.)

Config B (configuration B) of edible electronics is the second pre-conceived configuration for a wireless electrolytic power source charging circuit and a magnetic polarity inducer.

It functions to wireless charge the potentials of the electrolyte power sources embedded within the micro and / or nano capsule suspension at the outer walls of the core encapsulation. It is designed so that charging takes place when the capsule is adequately docked into the hard cased housing ξ .

In Config B, v denotes the AC to DC voltage regulator, the diodes (τ), in the circuit form a full-wave bridge rectifier and Λ denotes the electrolyte power source. Ψ denotes the organic ferrite (metal ion - e.g. Fe^+ ions) coil winding core.

All components and connecting ionic metallic strips are vapour deposited onto biodegradable substrates which are then lami-

nated onto the exposed inner bi-layer wall surface of the micro and / or nano encapsulated suspension core capsule. Both Config A and B are fully designed and fabricated with biodegradable edible electronic components and imprinting substrate
5 ions.

Fig. 8 shows a conceptualized process for laminating edible circuitry onto the exposed inner surface of the bi-layered micro / nano encapsulated suspension core encapsulation wall.
10

In this figure, Θ has been elaborated above and remains largely unchanged in this design. The outer wall membrane of the bi-layered encapsulation μ , has been peeled back, to reveal the edible electronic circuitry α which has been laminated onto the surface of the inner wall membrane Λ .
15

In step A, the layers are first fabricated and stacked on top of one another. The topmost layer β is the biodegradable predominant hydrophobic imprinting substrate (e.g. ethyl-cellulose) for the electrical circuitry. The second layer γ , beneath β is the hydrophilic sacrificial layer (e.g. starch and / or dextrin polynucleated species) which dissolves in contact with water. The third layer δ , beneath γ is a porous hydrophobic water insolvent substrate (e.g. filtered paper) which acts
20 as a flat stable backing for laminating and circuit imprinting activities.
25

Step B details a series of sequential stages wherein which the biodegradable circuitry, forming the intelligent edible electronics is being fabricated and laminated onto the inner bi-layer wall surface of the micro / nano encapsulation suspension core capsule.
30

In this step, at the sequence of stages detailed in Figure 2, ξ is the metal ion strip connected to organic field effect transistors (OFETs) which are formed through vapor deposition through atomization nozzle ε . Φ denotes the organic solar cells (OSCs) which are spin coated onto a silicon dioxide (SiO_2) food grade substrate. Ψ denotes the fourth organic layer which will be stacked on top of the vapour deposited electronic components to form an additional electric circuit imprinting substrate. Γ denotes another electronic component (e.g. gating circuitry) which is vapour deposited onto Ψ . λ is the final n-layered laminating substrate of imprinted edible circuitry which is ready for laminating onto the capsule inner bi-layer wall surface. In the laminating process, the layers are inverted to orient the circuitry facing downwards - in direct contact with the capsule wall surface. Next, water droplets (θ), are dripped onto δ . Due to the porosity of the hydrophobic layer δ , water seeps through this layer without being absorbed or reacted upon down onto layer γ , which is a predominantly hydrophilic species. Upon contact with water, layer γ dissolves and bio-degrades into harmless derivatives which are safe for consumption. As layer γ dissolves, leaving the interstitial directly facing surfaces of δ and β exposed to a nano columned layer of air, layer δ slides off easily, leaving layers β to λ with the imprinted embedded electronic circuitry in direct contact with the inner surface of the micro / nano encapsulated suspension core bi-layered shell wall. Layer λ , may be ionically or covalently bonded to the inner surface of the micro / nano encapsulated suspension core bi-layered shell wall. The laminated circuitry from layers β to λ are then further covered over by μ , of the outer micro / nano encapsulated suspension core bi-layered shell wall.

Although the current patent specification targets food and beverage microencapsulation with edible electronics for intelligent automated functions like product tagging, quality control, targeted release mechanisms, GI tract physiological monitoring, nutrient therapeutics, etc. The same embodiment can also be used for instances of microencapsulated medical devices, their intended applications and microencapsulated pharmaceutical drug administration. Furthermore, the proposed edible electronics and biodegradable circuitry are arbitrary designs and do not cover the full extent of any other holistic electrical or intelligent function or use by other circuit designs - which may be the basis framework (e.g. RF filters, counters, signal encoders, CPU / GPU and / or DSP chipsets, etc.) for imprinting onto the biodegradable hydrophobic food grade substrate to provide the intended utility of such circuits' intelligent functions.

CLAIMS

1. Microencapsulation wall material of a microencapsulation
product for food and beverage capsules, wherein the micro-
5 encapsulation wall material comprises
 - a hyper-polarizable hydrophilic polymer species
and/or hydrophobic polymer species,
 - a first mixture, wherein the first mixture comprises
at least one material out of the group of collagens,
10 chitosan, silk fibroin, gelatin, alginate, modified
starch, and biopolymers, and
 - a second mixture, wherein the second mixture com-
prises at least one material out of the group of a
lecithin, cyclodextrin and whey surfactant base mix-
15 ture,wherein the first mixture and the second mixture form an
emulsion.
2. Microencapsulation wall material according to claim 1,
20 wherein the microencapsulation wall material has an HLB
value within the range of ≤ 10 .
3. Microencapsulation wall material according to claim 1,
wherein the microencapsulation wall material has an HLB
25 value within the range of ≥ 10 .
4. Microencapsulation wall material according to claim 4,
wherein molecules of the hyper-polarizable hydrophilic or
hydrophobic polymer species have been processed so as to be
30 hyper-polarized.
5. A suspension core capsule, wherein the suspension core cap-
sule comprises a wall comprising microencapsulation wall

material according to one of the claims 1 to 4 and a ferrous nutrient core, in particular, a positively charged ferrous nutrient core.

- 5 6. A suspension core capsule according to claim 5, wherein the wall is a bilayer wall, comprising an inner wall comprising microencapsulation wall material according to claim 1 to 4, and an outer wall comprising microencapsulation wall material according to claim 1 to 4.
- 10 7. A suspension core capsule according to claim 6, wherein an outside of the inner wall and an inside of the outer wall are touching each other.
- 15 8. A suspension core capsule according to any of the claims 6 to 7, wherein the inner wall and the outer wall have a pre-defined thickness.
9. A suspension core capsule according to any of the claims 4
20 to 7, wherein the wall comprises a timed release mechanism to release nutrients.
10. A suspension core capsule according to claim anyone of claims 5 to 9, wherein the ferrous nutrient core comprises
25 iron, magnesium, manganese, copper and zinc ions.
11. A suspension core capsule according to any one of claims 5 to 10, wherein the hyper-polarizable hydrophilic or hydrophobic polymer species molecules have been treated so as to
30 be hyper-polarized.
12. A suspension core capsule according to any one of the preceding claims, wherein the hyper-polarizable hydrophilic or

hydrophobic polymer species is arranged radially inside and outside the inner wall.

13. A suspension core capsule according to any one of claims 5
5 to 11, wherein the hyper-polarizable hydrophilic or hydrophobic polymer species is arranged radially at the outer wall.
14. A suspension core capsule according to any one of claims 5
10 to 13, wherein the capsule further comprises a neutrally charged membrane arranged radially at the outer surface of the microencapsulated bilayer wall, wherein the neutrally charged membrane comprising lipid-like chain segments.
- 15 15. Method for producing a microencapsulation wall material, wherein the method comprises the following steps:
- providing a first mixture, wherein the first mixture comprises at least one material out of the group of collagens, chitosan, silk fibroin, gelatin, alginate,
20 modified starch, and biopolymers,
 - providing a second mixture, wherein the second mixture comprises at least one material out of the group of a lecithin, cyclodextrin and whey surfactant base mixture,
 - 25 - forming an emulsion with the first mixture and the second mixture, and
 - wherein the wall material comprises a hyper-polarizable hydrophilic or hydrophobic polymer species.
- 30 16. Method for producing a microencapsulation wall material according to claim 15, further comprising a step of atomizing the emulsion into vapor microparticles.

17. Method for producing a microencapsulation wall material according to claim 15 or 16, further comprising a step of providing a homogenizer.
- 5 18. Method for producing a suspension core capsule comprising the method steps of the method according to the claims 15 to 16 and further comprising the method steps of:
- providing a ferrous nutrient core,
 - providing a microencapsulated wall material, and
 - 10 - encapsulating the microencapsulated wall material around the ferrous nutrient core.
19. Method according to claim 18, the method further comprising a step of applying a static and/or dynamic electromagnetic field gradient to the suspension core capsule, in particular, applying a magnetic north polarity to the suspension core capsule by an externally applied polarized magnet at opposing ends of a circular profile of the wall material, thereby inducing a dipole moment to the molecules or atoms of the hyper-polarizable hydrophilic or hydrophobic polymeric species.
- 15 20. Method according to claim 18, the method further comprising a step of applying a reversed magnetic south polarity to the suspension core capsule by an externally applied polarized magnet at opposing ends of a circular profile of the wall material, thereby causing the molecules or atoms of the hyper-polarizable hydrophilic or hydrophobic polymeric species to reverse the orientation of their dipole spins moment.
- 20 21. Production system for producing a suspension core capsule, wherein the production system comprises a homogenizer, an
- 30

atomizer, an emulsification bath, a spray nozzle, mixer, a spray chamber, a cooker, a holding tank, a dispersion system, an encapsulation machine, and a magnet, wherein the system is configured to carry out a method according to one
5 of the claims 18 to 20.

22. An edible capsule, comprising
a wall comprising microencapsulation wall material according to one of claims 1 to 4 forming a core, and an electronic component included in the core, wherein the wall is
10 a bilayer wall, comprising an inner wall comprising microencapsulation wall material according to claim 1 to 4, and an outer wall comprising microencapsulation wall material according to claim 1 to 4.

15

23. Edible capsule according to claim 22, wherein the electronic component is comprised of biodegradable, edible parts.

20 24. Edible capsule according to claim 22 or 23, wherein the electronic component is located on the surface of the inner wall.

25 25. Edible capsule according to any of claim 22 to 24, wherein the electronic component comprises a wireless sensor for sensing data and a wireless transceiver and for communicating the sensed data to a receiver.

30 26. Edible capsule according to any of claim 22 to 24, wherein the capsule further comprises an electrolytic power source charging circuit and a magnetic polarity inducer for charging potentials of electrolytic power sources embedded within the edible capsule.

27. Edible capsule according to claim 26, wherein the electrolytic power source is embedded at the outer wall of the core.
- 5
28. Edible capsule according to any of claim 22 to 27, wherein the electronic component serves for at least one of product tagging, quality control, targeted release mechanisms, GI tract physiological monitoring, nutrient therapeutics, pharmaceutical drug administration.
- 10
29. Method of producing an edible capsule of one of claims 22 to 28, comprising:
- 15 - Stacking several predetermined layers on top of one another, the topmost first layer (β) being a biodegradable predominant hydrophobic imprinting substrate for receiving electrical circuitry of the electrical component, the second layer (γ) beneath the first layer (β) being a hydrophilic sacrificial layer, which is adapted to dissolve in contact with water, the third layer (δ) beneath the second layer (γ) being a porous hydrophobic water insolvent substrate, which is adapted to act as a flat stable backing for laminating and circuitry imprinting,
 - 20 - forming organic field effect transistors through vapour deposition through atomization nozzle (ϵ),
 - 25 - forming, on the first layer (β), a metal ion strip (ξ) connected to the organic field effect transistors,
 - placing, onto the first layer (β), a silicon dioxide food grade substrate comprising organic solar cells (ϕ)
 - 30 - formed by spin coating onto the silicon substrate,
 - stacking on top of the metal ion strip and the solar cells a further organic layer (ψ) to form an additional electric circuit imprinting substrate,

- vapour-depositing further electronic circuitry (Γ) onto the further organic layer (Ψ), thus obtaining a laminating substrate (λ),
- 5 - inverting the layer laminating substrate to orient the circuitry facing downwards and bringing the inverted laminating layer in direct contact with the capsule wall surface,
- dripping water droplets (θ) onto the third layer (δ), the third layer (δ) letting the droplets pass to the
- 10 second layer (γ), thus dissolving and bio-degrading the hydrophilic second layer (γ) into edible derivatives which are safe for consumption,
- sliding off the third layer (δ), and bringing the laminating substrate (λ) including the first layer (β) with
- 15 the imprinted embedded electronic circuitry in direct contact with the inner wall of the encapsulated suspension core capsule produced with the method of any of claim 15 to 17,
- covering the circuitry by the outer wall (μ) produced
- 20 with the method of any of claim 15 to 17.

30. The method according to the claim 29, wherein the laminating layer (λ) is ionically or covalently bonded to the inner surface of the inner wall.

25

31. Non-biodegradable capsule suspension housing (ξ) comprising electronic circuitry (α , β , Σ , γ , δ) being fabricated with embedded non-organic electronics, the circuitry being adapted to act as a magnetic power

30 source for power transference to charge an (organic) electrolyte battery supply when the capsule according to one of claims 22 to 27 is docked into the housing (ξ).