SUMMARY

Examples herein include but are not limited to methods, devices, compositions, kits, materials, tools, instruments, reagents, products, compounds, pharmaceuticals, arrays, computer-implemented algorithms, and computer-implemented methods.

In one aspect, there is provided a method of producing an implantable collagen-containing medical device comprising the step of coating said collagen-containing medical device with ~~metal microparticles and/or metal nanoparticles~~ silver nanoparticles, wherein said step of coating said collagen-containing medical device is by sonication such that the collagen-containing medical device has anti-bacterial and anti-inflammatory properties on implantation compared to a~~the~~ medical device not coated with silver nanoparticles~~metal microparticles and/or metal nanoparticles~~.

In another aspect, the present disclosure provides a method for inhibiting biofilm formation on a medical implant, comprising the step of covering said implant with a collagen-containing membrane that has been coated with silver nanoparticles by sonication so as to prevent biofilm formation and/or growth of bacteria.

In yet another aspect, the present disclosure provides a method for inhibiting microbial colonization on a medical device or implant, comprising covering said device or implant with a collagen-containing membrane that has been coated with silver nanoparticles by sonication so as to prevent microbial colonization.

In yet another aspect, the present disclosure provides a package comprising a collagen-containing medical device that is coated with silver nanoparticles, wherein said silver nanoparticles have been applied by sonication, wherein said device is sealed in an airtight or vacuum-packed container.

In one example, the medical device can be delivered into a host organism, such as a human or animal, or used *in vitro*. The medical device may comprise plasmids, genes, nucleic acids, or a DNA or RNA virus.

In another example, the coating covers at least a portion of said device. The metal micro and/or nanoparticle coating can further comprise natural or synthetic polymers, metal, metal oxide, oxide, metal nitride, borate, ceramic, zirconia, allograft hard tissue, allograft soft tissue, xenograft hard tissue, xenograft soft tissue, carbon nanostructure, carbon, glasses, natural, or biocompatible material. The coating is capable of performing at least one of treating infection, preventing infection; promoting cell adhesion; preventing biofilm formation, inhibiting biofilm formation; promoting cell proliferation; promoting binding with a biological or non-biological system, increasing or decreasing a cell function; delivering a drug and/or bioactive agent, or ensuring a better integration of a material into the host tissue.

In other examples, the coating comprises one or more layers of nanoparticles and/or microparticles. In still other examples, the one or more layers comprises a single type of nanoparticle and/or microparticle, or a combination of more than one type of nanoparticle and/or microparticle. Further, one or more layers comprises silver nanoparticles. In another example, one or more layers comprises a combination of metal, nanoparticles, metal oxides, carbon nanotubes, polymeric nanoparticles, ceramics, calcium phosphate, collagen, and/or hydroxyapatite nanoparticles. In other examples, the coating is biodegradable and/or biocompatible, and nanoparticles can be released from said nanoparticle composition as each layer degrades. In other

CLAIMS

1. A method of producing an implantable collagen-containing medical device comprising the step of coating said collagen-containing medical device with ~~metal microparticles and/or metal nanoparticles~~silver nanoparticles, wherein said step of coating said collagen-containing medical device is by sonication such that the collagen-containing medical device has anti-bacterial and anti-inflammatory properties on implantation compared to ~~the~~ a medical device not coated with ~~metal microparticles and/or metal nanoparticles~~silver nanoparticles.

~~2. A method according to claim 1, wherein the metal microparticles and/or metal nanoparticles comprise a metal selected from the group consisting of silver and copper or combinations thereof.~~

~~3~~2. A method according to claim 1, wherein the collagen-containing medical device is a collagen-containing membrane.

~~4~~3. A method according to claim 1, wherein the collagen-containing medical device is for delivery into a host organism or used *in vitro*.

~~5~~4. A method according to claim 4, wherein the host organism is a human or animal.

~~6~~5. A method according to claim 1, wherein the coating covers at least a portion of said device.

~~7~~6. A method according to claim 1, wherein the coating further comprises natural or synthetic polymer, metal, metal oxide, oxide, metal nitride, borate, ceramic, zirconia, allograft hard tissue, allograft soft tissue, xenograft hard tissue, xenograft soft tissue, carbon nanostructure, carbon, glasses, natural or biocompatible material.

~~8~~7. A method according to claim 1, wherein the ~~metal microparticles and/or metal nanoparticles~~ silver nanoparticles have a size range from ~~about~~ 0.5 nm to ~~about~~ 500 nm.

~~9~~8. A method according to claim 1, wherein the coating is capable of performing at least one of: treating infection; preventing infection; treating inflammation; preventing inflammation; promoting cell adhesion; preventing biofilm formation; inhibiting biofilm formation; promoting cell proliferation; promoting binding with a biological or non-

biological system; increasing or decreasing a cell function; delivering a drug and/or bioactive agent, or ensuring a better integration of a material into the host tissue.

~~10. A method according to claim 1, wherein the coating comprises metal microparticles and metal nanoparticles.~~

~~11. A method according to claim 1, wherein the coating comprises metal nanoparticles.~~

~~12~~9. A method according to claim 1, wherein the coating comprises one or more layers of ~~metal nanoparticles and/or metal microparticles~~silver nanoparticles.

~~13. A method according to claim 12, wherein the one or more layers comprises silver nanoparticles.~~

~~14~~10. A method according to claim 1, wherein the medical device is an orthopaedic implant, dental implant, veterinary prosthetic device, a scaffold or a tissue engineering matrix.

~~15~~11. A method according to claim ~~14~~10, wherein the orthopaedic implant is a hip implant, knee implant or shoulder implant.

~~16~~12. A method according to claim ~~14~~11, wherein the dental implant is an abutment.

~~17~~13. A method for inhibiting biofilm formation on a medical implant, comprising the step of covering said implant with a collagen-containing membrane that has been coated with silver nanoparticles by sonication so as to prevent biofilm formation and/or growth of bacteria.

~~18~~14. A method according to claim ~~17~~13, wherein the biofilm is a bacterial, a fungal, or a protozoan biofilm.

~~19~~15. A method according to claim ~~17~~13, wherein the medical implant is an orthopaedic or a dental implant, a scaffold or a tissue engineering matrix.

~~20~~16. A method for inhibiting microbial colonization on a medical device or implant, comprising covering said device or implant with a collagen-containing membrane that has been coated with silver nanoparticles by sonication so as to prevent microbial colonization.

~~21~~17. A package comprising a collagen-containing medical device that is coated with silver nanoparticles, wherein said silver nanoparticles have been applied by sonication, wherein said device is sealed in an airtight or vacuum-packed container.