

TABLE 4

Count of colony-forming units on sheeting composed of ethylene-vinyl acetate (EVA rubber) and copper microparticles.				
Indicator strain	<i>Escherichia coli</i> (CFU)		<i>Staphylococcus aureus</i> (CFU)	
	0 h	24 h	0 h	24 h
Sampling time				
Control	8.9×10^5	3.3×10^6	5.0×10^5	6.9×10^7
material				
EVA rubber	—	2.5×10^2	—	5.6×10^4
% reduction	—	>99%	—	>99%

The invention claimed is:

1. A copper microparticle with antibacterial and/or biocidal activity, wherein each microparticle has a regular, crystalline and microstructured composition that comprises 5 different copper compounds: Antlerite $\text{Cu}_3^{+2}(\text{SO}_4)(\text{OH})_4$, Brochantite $\text{Cu}_4^{+2}\text{SO}_4(\text{OH})_6$, Chalcantite $\text{Cu}^{+2}\text{SO}_4 \cdot 5\text{H}_2\text{O}$, Natrochalcite $\text{NaCu}_2^{+2}(\text{SO}_4)_2 \cdot \text{OH} \cdot \text{H}_2\text{O}$ and Hydrated copper sulfate hydroxide $\text{Cu}_3(\text{SO}_4)_2(\text{OH})_2 \cdot 4\text{H}_2\text{O} / 2\text{CuSO}_4 \cdot \text{Cu}(\text{OH})_2$, with the microparticle having a size of between 5 and 50 μm .

2. The copper microparticle with antibacterial and/or biocidal activity as set forth in claim 1, wherein the microparticle has a size of between 10 and 40 μm .

3. The copper microparticle with antibacterial and/or biocidal activity as set forth in claim 1, wherein the microparticle has a size of between 10 and 15 μm .

4. The copper microparticle with antibacterial and/or biocidal activity as set forth in claim 1, wherein it can further comprise other metallic and nonmetallic antibacterial compounds.

5. The copper microparticle with antibacterial and/or biocidal activity as set forth in claim 4, wherein the metallic antibacterial compounds are zinc compounds, lead compounds, cadmium compounds, and silver compounds.

6. The copper microparticle with antibacterial and/or biocidal activity as set forth in claim 4, wherein the metallic antibacterial compounds are zinc compounds, lead compounds, cadmium compounds, and/or silver compounds.

7. A process for preparing copper microparticles with antibacterial and/or biocidal activity as set forth in claim 1, comprising the following steps:

- Preparing a solution of solubilized copper sulfate in distilled water in a ratio of 1:10 w/w;
- Adding to the solution obtained in step a) a 10% w/v sodium hydroxide solution and distilled water until a solution is obtained that has a pH of between 4 and 6;
- After 24 hours, separating the supernatant and the precipitate which is a copper hydroxide gel;
- Emulsifying the copper hydroxide gel precipitate of step c) in a copper sulfate solution in distilled water prepared in a ratio of 1:5 w/v;
- Subjecting the emulsion obtained in step d) to a drying process; and
- Obtaining the copper microparticle according to claim 1, wherein each microparticle has a regular, crystalline and microstructured composition that comprises 5 different copper compounds: Antlerite $\text{Cu}_3^{+2}(\text{SO}_4)(\text{OH})_4$, Brochantite $\text{Cu}_4^{+2}\text{SO}_4(\text{OH})_6$, Chalcantite $\text{Cu}^{+2}\text{SO}_4 \cdot 5\text{H}_2\text{O}$, Natrochalcite $\text{NaCu}_2^{+2}(\text{SO}_4)_2 \cdot \text{OH} \cdot \text{H}_2\text{O}$ and Hydrated copper sulfate hydroxide $\text{Cu}_3(\text{SO}_4)_2(\text{OH})_2 \cdot 4\text{H}_2\text{O} / 2\text{CuSO}_4 \cdot \text{Cu}(\text{OH})_2$.

8. The method according to claim 7, wherein the drying process is by means of a spray dryer.

9. The method according to claim 8, wherein the spray dryer has an inlet temperature between 220° C. and 280° C. and an outlet temperature between 80° C. and 100° C.

10. A concentrated polymeric composition (masterbatch) with antibacterial and/or biocidal activity comprising the copper microparticle as set forth in claim 1 wherein each microparticle has a regular, crystalline and microstructured composition that comprises 5 different copper compounds: Antlerite $\text{Cu}_3^{+2}(\text{SO}_4)(\text{OH})_4$, Brochantite $\text{Cu}_4^{+2}\text{SO}_4(\text{OH})_6$, Chalcantite $\text{Cu}^{+2}\text{SO}_4 \cdot 5\text{H}_2\text{O}$, Natrochalcite $\text{NaCu}_2^{+2}(\text{SO}_4)_2 \cdot \text{OH} \cdot \text{H}_2\text{O}$ and Hydrated copper sulfate hydroxide $\text{Cu}_3(\text{SO}_4)_2(\text{OH})_2 \cdot 4\text{H}_2\text{O} / 2\text{CuSO}_4 \cdot \text{Cu}(\text{OH})_2$, and at least one polymer or resin.

11. The concentrated polymeric composition (masterbatch) as set forth in claim 10, wherein the at least one polymer or resin corresponds to polypropylene (PP), polyethylene (PE), polyethylene terephthalate (PET), ethylene-vinyl acetate (EVA rubber), polystyrene (PS), styrene-butadiene rubber (SBR), polyvinyl chloride (PVC), polytetrafluoroethylene (PTFE), methacrylate (PMMA), polyester, aliphatic polyamides, polyterephthalamides, aramides (aromatic polyamides), rigid and flexible polyurethanes, or silicone.

12. A process for preparation of a concentrated polymeric composition (masterbatch) comprising:

- pulverizing a resin or polymeric material;
- creating a premixture by cold-mixing the pulverized resin or polymeric material and at least one microparticle according to claim 1 wherein each microparticle has a regular, crystalline and microstructured composition that comprises 5 different copper compounds: Antlerite $\text{Cu}_3^{+2}(\text{SO}_4)(\text{OH})_4$, Brochantite $\text{Cu}_4^{+2}\text{SO}_4(\text{OH})_6$, Chalcantite $\text{Cu}^{+2}\text{SO}_4 \cdot 5\text{H}_2\text{O}$, Natrochalcite $\text{NaCu}_2^{+2}(\text{SO}_4)_2 \cdot \text{OH} \cdot \text{H}_2\text{O}$ and Hydrated copper sulfate hydroxide $\text{Cu}_3(\text{SO}_4)_2(\text{OH})_2 \cdot 4\text{H}_2\text{O} / 2\text{CuSO}_4 \cdot \text{Cu}(\text{OH})_2$;
- heating the premixture to a molten state at a temperature between 120 and 250° C.; and
- passing the molten premixture through a pellet extruder to obtain a pellet masterbatch.

13. A process for preparation of a fiber, a filament, and/or a sheet having antibacterial activity on contact and with sustained effect comprising

- preparing a masterbatch according to claim 12;
- adding the masterbatch of step a) to a resin or polymer;
- heating the mixture of step b) to a molten state at a temperature between 120 and 250° C.; and
- extruding the molten mixture of step c) to form a fiber, a filament, and/or a sheet.

14. The process for preparation of a sheet according to claim 13, wherein the resin or polymer of step b) is selected from the group consisting of polyethylene (PE), polyamide (PA), polypropylene (PP), and/or polyethylene terephthalate (PET).

15. A process for preparation of a multilayer sheet having antibacterial activity on contact and with sustained effect comprising

- preparing a masterbatch according to claim 12;
- adding the masterbatch of step a) to a resin or polymer;
- heating the mixture of step b) to a molten state at a temperature between 120 and 250° C.;
- extruding the molten mixture of step c) to form a sheet; and
- repeating steps a) to d) at least once,
- wherein the extrusion of step e) occurs atop the sheet produced by step d) to produce a multilayer sheet.