Claims

1. A recycled rubber-based aerogel comprising a porous network of cross-linked recycled rubber fibres, wherein the recycled rubber-based aerogel has a thermal conductivity of 0.030-0.050 W/m K.

2. The recycled rubber-based aerogel according to claim 1, wherein the recycled rubber fibres comprised in the recycled rubber-based aerogel are obtained from tyres.

3. The recycled rubber-based aerogel according to claim 1 or 2, wherein the cross-linked recycled rubber fibres comprised in the recycled rubber-based aerogel are cross-linked with a thermoplastic polymer.

4. The recycled rubber-based aerogel according to claim 1 or 2, wherein the cross-linked recycled rubber fibres comprised in the recycled rubber-based aerogel are cross-linked with a cross-linker selected from: polyvinyl alcohol (PVA), glutaraldehyde (GA), poly(methyl methacrylate) (PMMA), polyamides, polylactic acid (PLA), polyvinyl chloride (PVC), or a combination thereof.

5. The recycled rubber-based aerogel according to claim 4, wherein the cross-linker is PVA.

6. The recycled rubber-based aerogel according to claim 4, wherein the cross-linker is a combination of PVA and GA.

7. The recycled rubber-based aerogel according to any preceding claim, wherein the recycled rubber-based aerogel has a density of 0.02-0.20 g/cm^3.

8. The recycled rubber-based aerogel according to any preceding claim, wherein the recycled rubber-based aerogel has a compressive Young's modulus of ≤ 5000 kPa.

9. The recycled rubber-based aerogel according to any preceding claim, wherein the recycled rubber-based aerogel is superhydrophobic and has a contact angle of 120-160°.

10. The recycled rubber-based aerogel according to any preceding claim, wherein the recycled rubber-based aerogel has a porosity of ≥ 80%.

11. A method of forming the recycled rubber-based aerogel according to any preceding claim, the method comprising:

- hydrolysing recycled rubber fibres to form hydrolysed recycled rubber fibres, wherein the hydrolysing forms at least carboxyl groups and hydroxyl groups on a surface of the hydrolysed recycled rubber fibres;
- cross-linking the hydrolysed recycled rubber fibres with a cross-linker;
- gelation of cross-linked recycled rubber fibres; and
- drying to form the recycled rubber-based aerogel.

12. The method according to claim 11, wherein the cross-linker is a thermoplastic polymer.

13. The method according to claim 11, wherein the cross-linker is: polyvinyl alcohol (PVA), glutaraldehyde (GA), poly(methyl methacrylate) (PMMA), polyamides, polylactic acid (PLA), polyvinyl chloride (PVC), or a combination thereof.

14. The method according to any of claims 11 to 13, wherein the method further comprises modifying the surface of the recycled rubber-based aerogel.

15. The method according to claim 14, wherein the modifying comprises treating the surface of the recycled rubber-based aerogel with a silane-based compound, amine-based compound, or a combination thereof.

16. The method according to claim 14 or 15, wherein the modifying comprises treating the surface of the recycled rubber-based aerogel with methoxytrimethylsilane (MTMS), methyltriethoxysilane (MTEOS), methyl(triacetoxy)silane, ethyl(triacetoxy)silane, propyl(triacetoxy)silane, methyltris(methylethylketoxime)silane, vinyltris(methylethylketoxime)silane, phenyltris(methylethylketoxime)silane , (3-

aminopropyl)tiethoxysilane (APTES), tetraethylenepentamine (TEPA), aminomethyl propanol (AMP), polyethylenimine (PEI), or a combination thereof.

17. The method according to any of claims 11 to 16, wherein the cross-linker is PVA.

18. The method according to claim 17, wherein the cross-linker further comprises GA.

19. The method according to any of claims 11 to 18, wherein the drying comprises: freeze-drying, ambient pressure drying, or a combination thereof.