Claims

1. A solvent-free method of encapsulating a hydrophobic active in personal care, hydrophobic active in crop protection or a hydrophobic active pharmaceutical ingredient (API) in polymeric nanoparticles, the method comprising:

mixing the hydrophobic active in a polymer melt, wherein the polymer melt comprises a melt of a block co-polymer, wherein the polymer melt acts as a solvent for the hydrophobic active;

dispersing the polymer melt in water to trigger spontaneous self-assembly of the polymeric nanoparticles; and

maintaining the polymer melt in water for sufficient time to continue self-assembly of the polymeric nanoparticles spontaneously occurring in the polymer melt, wherein the self-assembly of the polymeric nanoparticles comprises encapsulation of the hydrophobic active in the polymeric nanoparticles.

2. The method of claim 1, further comprising cooling the self-assembled dispersion to enhance the stabilization of the hydrophobic active encapsulated in the polymeric nanoparticles.

3. The method of claim 1 or 2, wherein the hydrophobic active is dissolved at a temperature above the melting temperature of the block co-polymer.

4. The method of claim 3, wherein the hydrophobic active is dissolved at least 1 °C above the melting temperature of the block co-polymer.

5. The method of any one of claims 1 to 4, wherein the polymer melt is dispersed in water at 0 to 50 °C higher than the melting temperature of the block co-polymer.

6. The method of any one of claims 1 to 5, wherein the polymer melt is maintained in water at 50 °C or lower.

7. The method of any one of claims 2 to 6, wherein the polymer melt is cooled to room temperature and below to aid storage and to enhance stabilization of the nanoparticles formed.

8. The method of claim 7, wherein the polymeric nanoparticles formed are cooled to room temperature.

9. The method of any one of claims 2 to 8, wherein the polymer melt is cooled at a rate of 0.25 to 1.5 °C/min.

10. The method of any one of claims 1 to 9, further comprising stirring the dispersion of the polymer melt in water to enhance the self-assembly process.

11. The method of claim 10, wherein the dispersion is stirred at a stirring rate of 50 rpm or higher.

12. The method of any one of claims 1 to 11, wherein the block co-polymer comprises a diblock co-polymer of poly (ethylene glycol)-poly-lactic acid, poly(ethylene glycol-poly(glycolic acid), poly(ethylene glycol)-poly-lactic-co-glycolic acid, poly(ethylene

glycol)- poly(butyl cyano-acrylate), poly(ethylene glycol)-block-poly hydroxybutyrate), poly(ethylene glycol)-poly-(hydroxypropionate), poly-(ethylene glycol)-(Valero lactone), poly(ethylene glycol)-poly(caprolactone) (PEG-PCL), poly-(ethylene glycol)-poly-(benzyl asparatate), poly-(ethylene glycol)-poly-(benzyl glutamate), poly(ethylene glycol)-poly-benzyloxy trimethylene carbonate, poly(ethylene glycol)-poly-butadiene, poly(ethylene glycol)-poly-(butyl acrylate), or a tri-block copolymer of any one of the above hydrophobic and hydrophilic components.

13. The method of claim 12, wherein the block co-polymer comprises a PEG block of 1,500 to 15,000 Da.

14. The method of claim 12 or 13, wherein the block co-polymer comprises a PCL block of 3,500 to 24,000 Da.

15. The method of any one of claims 1 to 14, wherein the hydrophobic active comprises of a compound in various therapeutic classes selected from the group consisting of beta-adrenoceptor blocking agents, contrast media, corticosteroids, cough suppressants, diagnostic agents, diagnostic imaging agents, diuretics, dopaminergics, haemostatics, immunological agents, lipid regulating agents, muscle relaxants, parasympathomimetics, parathyroid calcitonin, prostaglandins, radio-pharmaceuticals, sex hormones, anti-allergic agents, stimulants, sympathomimetics, thyroid agents, vasodilators, xanthines, analgesics, anti-inflammatory agents, anthelmintics, anti-arrhythmic agents, antibiotics, anticoagulants, antidepressants, antidiabetic agents, antiepileptics, antihistamines, antihypertensive agents, antimuscarinic agents,

antimycobacterial agents, antineoplastic agents, immunosuppressants, antithyroid agents, antiviral agents, anxiolytic sedatives and astringents.

16. The method of claim 15, wherein the hydrophobic active comprises ibuprofen, fenofibrate, ketoconazole, PM2 peptide, or citronellal, Itraconazol, isotretionoin, β-carotene, retinal, retinoic acid, curcumin, doxorubicin, SN-38, paclitaxel, camptothecin, cisplatin, daunorubicin, methotrexate, mitomycin C, docetaxel, vincristine,amphotericin B, nystatin, prostaglandins, cyfluthrin, butanilicaine, fomocaine, isobutambene, lidocaine, risocaine, pseudococaine, prilocaine, tetracaine, trimecaine, tropacocaine, etomidate, metixen, profenamine, alimenazine, binedaline, perazine, chlorpromazine, fenpentadiol, fenanisol, mebenazine, methylphenidate, thioridazine, toloxaton, trimipramide, dimethadion, nicethamide, butoconazole, chlorphenesin, etisazole, exalamid, precilocine, miconazole, butibufen, azinphosphomethyl, cypermethrine, substituted phenyl thiophosphates, fenclophos, permethrine, piperonal, tetramethrine and/or trifluraline, viquidile, asperline, chlorambucile, mitotane, estramustine, taxol, penclomedine, trofosfamide, capsaicine, methylnicotinate, nicolclonate, oxprenolol, pirifibrate, simfibrate, thiadenol, aminopromazine, caronerine, difemerine, fencarbamide, tiropramide, moxaverine, testosterone enantate, testosterone-(4-methylpentanoate), azaperone, buramate, arildon, retinol, retinol acetate, retinol palmitate, tocopherol acetate, tocopherol succinate, tocopherol nicotinate, menadione, cholecalciferol, acephate bamifylline, alprenolol, butobendine, clordiazole, hexobendine, nicofibrate, penbutolol, pirmenol, prenylamine, procaine amide, propatrylnitrate, suloctidil, toliprolol, xidbendol, viquidile, asperline, chlorambucile, mitotane, estramustine, taxol and macrolide antibiotics.

17. The method of any one of claims 1 to 14, wherein the hydrophobic active comprises a crop protecting agent or a personal care agent.

18. The method of claim 17, wherein the crop protecting agent comprises pyrithrins.

19. The method of any one of claims 1 to 18, further comprising separating the hydrophobic active encapsulated polymeric nanoparticles.

20. The method of claim 19, wherein hydrophobic active encapsulated polymeric nanoparticles are separated by ultracentrifugation, ultrafiltration, spray drying or freeze drying.

21. The method of any one of claims 1 to 20, wherein the polymer melt further comprises a homo-polymer.

22. The method of claim 21, wherein the homo-polymer is selected from the group consisting of poly(ethylene glycol) (PEG), poly(lactic acid) (PLA), poly(glycolic acid) (PGA), and poly(caprolactone) (PCL).

23. Hydrophobic active pharmaceutical ingredient encapsulated polymeric nanoparticles formed by a method of any one of claims 1 to 22, wherein each of the hydrophobic active pharmaceutical ingredient encapsulated polymeric nanoparticles comprises (i) a block co-polymer and (ii) a hydrophobic active which comprises a crop protecting agent or a personal care agent, wherein the hydrophobic active together with

the block co-copolymer render faster formation of the hydrophobic active pharmaceutical ingredient encapsulated polymeric nanoparticles.

24. An aqueous, spray dried or freeze dried formulation comprising hydrophobic active pharmaceutical ingredient encapsulated polymeric nanoparticles formed by a method of any one of claims 1 to 22 for use as a pharmaceutical or personal care product, wherein each of the hydrophobic active pharmaceutical ingredient encapsulated polymeric nanoparticles comprises (i) a block co-polymer and (ii) a hydrophobic active which comprises a crop protecting agent or a personal care agent, wherein the hydrophobic active together with the block co-copolymer render faster formation of the hydrophobic active pharmaceutical ingredient encapsulated polymeric nanoparticles.