These and other objects, advantages and features of the present invention will become apparent from the following specification taken in conjunction with the claims set forth herein.

BRIEF SUMMARY

Methods for stabilizing use solutions for detergent warewashing and stabilizing enzymes in detergent and multi-use compositions, in particular high temperature detergent applications to prolong enzyme stability and cleaning performance, are provided according to the present disclosure. An advantage of the present disclosure is the prolonged stability of enzymes, namely protease enzymes, and prolonged stability of use solutions of cleaning compositions at high temperatures for various detergent applications in comparison to compositions and use solutions of compositions that do not include the stabilizing agents disclosed herein.

In an aspect, there is provided a multi-use solid detergent composition comprising: from 60 wt-% to 85 wt-% of an alkali metal carbonate alkalinity source; from 0.1 wt-% to 5 wt-% of a protease enzyme; from 0.1 wt-% to 10 wt-% of a nitrogen-containing or a soluble starch or polysaccharide stabilizing agent; and water; ~~wherein said detergent has an alkaline pH of at least about 9; and~~ wherein a solid detergent block is produced from the detergent composition, a detergent use solution of the composition has a pH of at least 9, and the protease enzyme ~~maintains cleaning performance~~ retains 40% of its enzyme activity at temperatures of at least ~~about~~ 65°C in use solution for at least ~~about~~ 20 minutes. In an embodiment, the present disclosure includes detergent use solutions for removing soils, including protein soils, from a surface of a substrate and preventing redeposition of protein soils onto the surface of the substrate. The detergent use solutions beneficially reduce and/or prevent foaming in the cleaning application providing further benefits of use. The use solutions according to embodiments of the present disclosure include an alkali metal carbonate alkalinity source, protease enzymes and a stabilizing agent, such as for example an amine such as a casein or gelatin (nitrogen-containing stabilizer) or a poly sugar (starch-based stabilizer).

In another aspect, there is provided a stabilized multi-use detergent use solution composition produced by the process comprising: providing a detergent ~~use~~ composition

comprising: from 60 wt-% to 85 wt-% of an alkali metal carbonate alkalinity source; from 0.1 wt-% to 5 wt-% of a protease enzyme; from 0.1 wt-% to 10 wt-% of ~~either~~ an amine, amide, polyamide and/or polyamine stabilizing agent or a polysaccharide stabilizing agent; and water, wherein said detergent ~~use~~ composition is provided in one or more solid ~~and/or liquid~~ compositions ~~to generate said use composition~~; contacting the solid detergent composition with a diluent to generate an aqueous use solution; wherein said use solution has an alkaline pH of at least ~~about~~ 9; wherein said protease enzyme retains at least 40% of its enzymatic activity in said use solution for at least 20 minutes at temperatures between ~~about~~ 65-80°C. In yet another aspect, there is provided a method of cleaning using a stabilized multi-use detergent composition comprising: generating a use solution of a detergent composition comprising from 60 wt-% to 85 wt-% of an alkali metal carbonate alkalinity source, from 0.1 wt-% to 10 wt-% of a protease enzyme, from 0.1 wt-% to 10 wt-% of ~~either~~ a nitrogen-containing stabilizing agent or a soluble starch or polysaccharide stabilizing agent, and water, wherein said detergent composition is provided in one or more solid ~~and/or liquid~~ compositions; contacting a surface with said use solution; and cleaning said surface with said use solution, wherein said use solution has an alkaline pH of at least ~~about~~ 9, and wherein said protease retains at least 40% of its enzymatic activity in said use solution for at least 20 minutes at temperatures between ~~about~~ 65-80°C. In a further embodiment, the present disclosure includes methods of stabilizing multi-use detergent use solutions and employing the same for removing soils, including protein soils, from a surface of a substrate and preventing redeposition of protein soils onto the surface of the substrate. The methods include generating and introducing a stabilized, enzyme-containing detergent use solution during a washing step of a wash cycle, washing the surface of the substrate with the use solution during the wash cycle, and subsequently rinsing the surface of the substrate (with or without a rinse aid). The generating of the use solution and wash cycle according to the present disclosure for cleaning a substrate is suitable for use at high temperatures and pH over extended periods of time, including for example at

What is claimed is:

1. A multi-use solid detergent composition comprising:

from 60 wt-% to 85 wt-% of an alkali metal carbonate alkalinity source;

from 0.1 wt-% to 5 wt-% of a protease enzyme;

from 0.1 wt-% to 10 wt-% of a nitrogen-containing or a soluble starch or polysaccharide stabilizing agent; and

water;

~~wherein said detergent has an alkaline pH of at least about 9; and~~

wherein a solid detergent block is produced from the detergent composition,

a detergent use solution of the composition has a pH of at least 9, and the protease enzyme ~~maintains cleaning performance~~retains 40% of its enzyme activity at temperatures of at least ~~about~~ 65°C in use solution for at least ~~about~~ 20 minutes.

2. The composition of claim 1, wherein said stabilizing agent is an amine, amide, polyamide and/or polyamine.

3. The composition of claim 1, wherein said stabilizing agent is a casein ~~or~~, gelatin ~~stabilizer~~, ~~combinations of casein and gelatin (e.g. Amino 1000)~~ ~~,or~~ derivative thereof, or a combination thereof.

4. The composition of claim 1, wherein said stabilizing agent is ~~a polysugar~~ selected from the group consisting of amylose, amylopectin, pectin, inulin, modified inulin, potato starch, modified potato starch, corn starch, modified corn starch, wheat starch, modified wheat starch, rice starch, modified rice starch, cellulose, modified cellulose, dextrin, dextran, maltodextrin, cyclodextrin, glycogen, oligiofructose ~~and other~~, a soluble or~~;~~ partially soluble starch~~es or modified~~, derivatives thereof, and a confirmation thereof.

5. The composition of claim 1, wherein said stabilizing agent is an amylose and/or amylopectin-containing starch.

6. The composition of claim 1, wherein said detergent composition comprises between ~~about 50~~70 wt-% and ~~about~~ 85 wt-% alkali metal carbonate~~, between about 5 wt-% and about 30 wt-% water, between about 0.01 wt-% and about 5 wt-% protease enzyme, and between about 0.01 wt-% and about 30 wt-% stabilizing agent~~.

7. The composition of claim 1, further comprising at least one component selected from the group consisting of a surfactant or surfactant system, a chelating agent and an additional enzyme ~~stabilizing agent~~stabilizer.

8. The composition of claim 1, wherein said detergent composition is phosphorus-free, nitrilotriacetic acid-free, or both~~is substantially free of phosphorus and/or NTA~~.

9. A stabilized multi-use detergent use solution composition produced by the process comprising:

providing a detergent ~~use~~ composition comprising: from 60 wt-% to 85 wt-% of an alkali metal carbonate alkalinity source; from 0.1 wt-% to 5 wt-% of a protease enzyme; from 0.1 wt-% to 10 wt-% of ~~either~~ an amine, amide, polyamide and/or polyamine stabilizing agent or a polysaccharide stabilizing agent; and water, wherein said detergent ~~use~~ composition is provided in one or more solid ~~and/or liquid~~ compositions ~~to generate said use composition~~;

contacting the solid detergent composition with a diluent to generate an aqueous use solution;

wherein said use solution has an alkaline pH of at least ~~about~~ 9;

wherein said protease enzyme retains at least 40% of its enzymatic activity in said use solution for at least 20 minutes at temperatures between ~~about~~ 65-80°C.

10. The composition of claim 9, wherein ~~the stabilizing agent results in~~said protease enzyme retains at least ~~about~~ 40% of its protease enzymatic activity for ~~said period of time~~at least 40 minutes.

11. The composition of claim 10, wherein said stabilizing agent is a casein ~~or~~, gelatin stabilizer, or ~~combinations of the same (e.g. Amino 1000)~~combination thereof.

12. The composition of claim 10, wherein said stabilizing agent is an amylose and/or amylopectin-containing starch.

13. The composition of claim 9, wherein said use solution comprises between ~~about 50~~70 wt-% and ~~about~~ 85 wt-% alkali metal carbonate ~~actives, between about 5 wt-% and about 30 wt-% water, between about 0.01 wt-% and about 5 wt-% protease enzyme, and between about 0.0001 wt-% and about 30 wt-% stabilizing agent actives~~.

14. The composition of claim 9, wherein said use solution has at least ~~about~~ 60% protease enzymatic activity retained for ~~said period of time~~at least 20 minutes, and wherein said use solution comprises between ~~about~~ 10 ppm and 2000 ppm actives stabilizing agent and between ~~about~~ 0.1 ppm to 100 ppm protease enzyme.

15. The composition of claim 9, wherein said detergent use solution contains at least one additional functional ingredient selected from the group consisting of defoaming agents, anti-redeposition agents, bleaching agents, surfactants, solubility modifiers, dispersants, rinse aids, polymers, metal protecting agents, additional stabilizing agents, corrosion inhibitors, sequestrants and/or chelating agents, fragrances and/or dyes, rheology modifiers or thickeners, hydrotropes or couplers, buffers, solvents, and combinations thereof.

16. A method of cleaning using a stabilized multi-use detergent composition comprising:

generating a use solution of a detergent composition comprising from 60 wt-% to 85 wt-% of an alkali metal carbonate alkalinity source, from 0.1 wt-% to 10 wt-% of a protease enzyme, from 0.1 wt-% to 10 wt-% of ~~either~~ a nitrogen-containing stabilizing agent or a soluble starch or polysaccharide stabilizing agent, and water, wherein said detergent composition is provided in one or more solid ~~and/or liquid~~ compositions;

contacting a surface with said use solution; and

cleaning said surface with said use solution, wherein said use solution has an alkaline pH of at least ~~about~~ 9, and wherein said protease retains at least 40% of its enzymatic activity in said use solution for at least 20 minutes at temperatures between ~~about~~ 65-80°C.

17. The method of claim 16, wherein said protease enzyme retains at least ~~about~~ 60% of its enzymatic activity ~~is retained~~ for ~~said period of time~~at least 20 minutes.

18. The method of claim 16, wherein said protease enzyme retains at least ~~about~~ 30% of its enzymatic activity ~~is retained~~ for at least ~~about~~ 60 minutes at the pH of at least ~~about~~ 9 and temperatures between ~~about~~ 65-80°C.

19. The method of claim 16, wherein said enzyme is present in the use solution at a concentration of between ~~about~~ 0.1 ppm and ~~about~~ 100 ppm and wherein said stabilizing agent is present in the use solution at a concentration of between ~~about~~ 0.1 ppm and ~~about~~ 10,000 ppm ~~actives~~.

20. The method of claim 16, wherein said enzyme is present in the use solution at a concentration of between ~~about~~ 0.1 ppm and ~~about~~ 100 ppm and wherein said stabilizing agent is present in the use solution at a concentration of between ~~about~~ 10 ppm and ~~about~~ 1,000 ppm ~~actives~~.

21. The method of claim 16, wherein said surface is a surface of a ware.

22. The method of claim 16, wherein said detergent composition is a multi-use solid detergent composition.

23. The method of claim 16, wherein said use solution is introduced to a washing step of a wash cycle ~~and enhances soil removal and/or prevents redeposition of soils and maintains low foaming of a wash water source~~.