

WHAT IS CLAIMED IS:

1. A stopper for a syringe assembly, the stopper comprising a thermoplastic elastomer, wherein the compression set of the thermoplastic elastomer is $\leq 50\%$ when measured at 25% compression for 22 hrs at 70 degrees C, wherein the hardness of the thermoplastic elastomer is 40-70 Shore A, and wherein the viscosity of the thermoplastic elastomer is ≥ 70.0 Pa.s at $1,000 \text{ s}^{-1}$ shear rate, ≥ 12.0 Pa.s at $10,000 \text{ s}^{-1}$ shear rate, and ≥ 3.0 Pa.s at $50,000 \text{ s}^{-1}$ shear rate, wherein the stopper has a hard polymer phase and an elastomeric phase, and wherein the thermoplastic elastomer is a non-lubricated thermoplastic elastomer.

2. The stopper of claim 1, wherein the compression set of the thermoplastic elastomer is $\leq 35\%$ when measured at 25% compression for 22 hrs at 70 degrees C.

3. The stopper of claim 1, wherein the compression set of the thermoplastic elastomer is 10% - 35% when measured at 25% compression for 22 hrs at 70 degrees C.

4. The stopper of claim 1, wherein the hardness of the thermoplastic elastomer is 45-65 Shore A.

5. The stopper of claim 1, wherein the hardness of the thermoplastic elastomer is 53-63 Shore A.

6. The stopper of claim 1, wherein the viscosity of the thermoplastic elastomer is 70.0 Pa.s - 320.0 Pa.s at $1,000 \text{ s}^{-1}$ shear rate.

7. The stopper of claim 1, wherein the viscosity of the thermoplastic elastomer is 100.0 Pa.s - 170.0 Pa.s at $1,000 \text{ s}^{-1}$ shear rate.

8. The stopper of claim 1, wherein the viscosity of the thermoplastic elastomer is 12.0 Pa.s - 46.0 Pa.s at $10,000 \text{ s}^{-1}$ shear rate.

9. The stopper of claim 1, wherein the viscosity of the thermoplastic elastomer is 16.0 Pa.s - 27.0 Pa.s at 10,000 s⁻¹ shear rate.

10. The stopper of claim 1, wherein the viscosity of the thermoplastic elastomer is 3.0 Pa.s - 12.0 Pa.s at 50,000 s⁻¹ shear rate.

11. The stopper of claim 1, wherein the viscosity of the thermoplastic elastomer is 4.5 Pa.s - 7.5 Pa.s at 50,000 s⁻¹ shear rate.

12. A syringe assembly, comprising:

a syringe barrel having a proximal end, a distal end, and a sidewall extending therebetween and defining a chamber having an interior;

a stopper disposed within the interior of the syringe barrel, the stopper comprising a thermoplastic elastomer, wherein the compression set of the thermoplastic elastomer is $\leq 50\%$ when measured at 25% compression for 22 hrs at 70 degrees C, wherein the hardness of the thermoplastic elastomer is 40-70 Shore A, and wherein the viscosity of the thermoplastic elastomer is ≥ 70.0 Pa.s at 1,000 s⁻¹ shear rate, ≥ 12.0 Pa.s at 10,000 s⁻¹ shear rate, and ≥ 3.0 Pa.s at 50,000 s⁻¹ shear rate, wherein the stopper has a hard polymer phase and an elastomeric phase, and wherein the thermoplastic elastomer is a non-lubricated thermoplastic elastomer; and

a plunger rod having a first end engageable with a portion of the stopper.

13. The syringe assembly of claim 12, wherein the syringe barrel has a barrel material composition and the stopper has a stopper composition that is different than the barrel material composition.

14. The syringe assembly of claim 13, wherein the barrel material formulation comprises polypropylene and the hard phase of the formulation of the stopper does not comprise polypropylene.

15. The syringe assembly of claim 12, wherein the stopper has the hard polymer phase having a high melt temperature > 170 °C.

16. The syringe assembly of claim 15, wherein the hard phase comprises at least one of ethylene-tetra-fluoro-ethylene, and fluorinated ethylene propylene polymers.

17. A syringe assembly, comprising:

a syringe barrel having a proximal end, a distal end, and a sidewall extending therebetween and defining a chamber having an interior, the syringe barrel having a barrel material formulation;

a stopper comprising a thermoplastic elastomer, wherein the compression set of the thermoplastic elastomer is $\leq 50\%$ when measured at 25% compression for 22 hrs at 70 degrees C, wherein the hardness of the thermoplastic elastomer is 40-70 Shore A, and wherein the viscosity of the thermoplastic elastomer is ≥ 70.0 Pa.s at $1,000\text{ s}^{-1}$ shear rate, ≥ 12.0 Pa.s at $10,000\text{ s}^{-1}$ shear rate, and ≥ 3.0 Pa.s at $50,000\text{ s}^{-1}$ shear rate, wherein the stopper has a hard polymer phase and an elastomeric phase, and wherein the thermoplastic elastomer is a non-lubricated thermoplastic elastomer, the stopper slidably disposed within the interior of the chamber of the syringe barrel, the stopper sized relative to the interior of the chamber of the syringe barrel to provide sealing engagement with the sidewall of the syringe barrel and

a plunger rod having a first end engageable with a portion of the stopper,

wherein the formulation of the stopper is different than the barrel material formulation.