SUMMARY

[0004] The present disclosure relates to a medical delivery device having a barrel with a hydrophobic inner surface and a stopper that can provide air and liquid impermeability while also possessing one or more of: a low break loose force, a low average glide force, and a low glide force variation.

[0004a] In a first aspect, the present disclosure provides a medical delivery device comprising: a barrel having an inner surface; and a stopper contacting at least a portion of the inner surface of the barrel; said stopper having a compressibility between about 4.5% to about 7.9% measured against said barrel, wherein said inner surface of barrel has a water contact angle greater than 90º, and wherein the stopper has a sliding surface less than about 2 mm.

[0004b] In a second aspect, the present disclosure provides a medical delivery device comprising: a barrel having a first end, a second end, and an inner surface; a stopper contacting at least a portion of the inner surface of the barrel, the stopper having a compressibility between about 4.5% and about 7.9% when measured against the barrel; and an injection member coupled to the barrel, wherein the inner surface of the barrel has a water contact angle greater than 90º, and wherein the stopper has a sliding surface less than about 2 mm.

[0004c] In a third aspect, the present disclosure provides a medical delivery device comprising: a barrel having an inner surface; and a stopper contacting at least a portion of the inner surface of the barrel; said stopper having a compressibility between about 4.5% to about 7.9% measured against said barrel, wherein said inner surface of barrel has a water contact angle greater than 90º, and wherein the stopper has a sliding surface from about 2 mm to about 3.2 mm.

[0004d] In a fourth aspect, the present disclosure provides a medical delivery device comprising: a barrel having a first end, a second end, and an inner surface; a stopper contacting at least a portion of the inner surface of the barrel, the stopper having a compressibility between about 4.5% and about 7.9% when measured against the barrel; and an injection member coupled to the barrel, wherein the inner surface of the barrel has a water contact angle greater than 90º, and wherein the stopper has a sliding surface from about 2 mm to about 3.2 mm.

[0004e] In a fifth aspect, the present disclosure provides a medical delivery device comprising: a barrel having an inner surface; and a stopper contacting at least a portion of the inner surface of the barrel; said stopper having a compressibility greater between about 7.9% and about 17% measured against said barrel, wherein said inner surface of barrel has a water contact angle greater than 90º, and wherein the stopper has a sliding surface greater than about 2 mm.

[0004f] In a sixth aspect, the present disclosure provides a medical delivery device comprising: a barrel having a first end, a second end, and an inner surface; a stopper contacting at least a portion of the inner surface of the barrel, the stopper having a compressibility greater than about 7.9% when measured against the barrel; and an injection member coupled to the barrel, wherein the inner surface of the barrel has a water contact angle greater than 90º, and wherein the stopper has a sliding surface greater than about 2.

[0004g] In a seventh aspect, the present disclosure provides a medical delivery device comprising: a barrel having an inner surface; and a stopper contacting at least a portion of the inner surface of the barrel; said stopper having a compressibility between about 7.9% and about 17% measured against said barrel, wherein said inner surface of barrel has a water contact angle greater than 90º, and wherein the stopper has a sliding surface less than about 2 mm.

[0004h] In an eighth aspect, the present disclosure provides a medical delivery device comprising: a barrel having a first end, a second end, and an inner surface; a stopper contacting at least a portion of the inner surface of the barrel, the stopper having a compressibility between about 7.9% and about 17% when measured against the barrel; and an injection member coupled to the barrel, wherein the inner surface of the barrel has a water contact angle greater than 90º, and wherein the stopper has a sliding surface less than about 2 mm.

[0005] One embodiment relates to a medical delivery device that includes a barrel and a stopper contacting at least a portion of the inner surface of the barrel. The inner surface of the barrel is hydrophobic. The surface energy of the barrel portion that is in contact with the stopper is such that the water contact angle is above 90º. The stopper has a glide force variation less than about 1.3 N when calculated according to

the Glide Force Variation test method described herein. In some embodiments, the stopper has an average glide force less than about 4 N. In addition, the stopper further includes a sliding surface that is less than about 2.0 mm measured at a compressibility from about 4.5% to about 7.9%. Additionally, the stopper may have a break loose force of less than about 7.0 N.

[0006] A second embodiment relates to a medical delivery device that includes a barrel and a stopper contacting at least a portion of the inner surface of the barrel. The inner surface of the barrel is hydrophobic. The surface energy of the barrel portion that is in contact with the stopper is such that the water contact angle is above 90º. The stopper has a glide force variation less than about 1.3 N when calculated according to the Glide Force Variation test method described herein. In some embodiments, the stopper has an average glide force less than about 7 N. In addition, the stopper further includes a sliding surface from about 2.0 mm to about 3.2 mm measured at a compressibility from about 4.5% to about 7.9%. Additionally, the stopper may have a break loose force from about 4.0 N to about 10 N.

[0007] A third embodiment relates to a medical delivery device that includes a barrel and a stopper contacting at least a portion of the inner surface of the barrel. The inner surface of the barrel is hydrophobic. The surface energy of the barrel portion that is in contact with the stopper is such that the water contact angle is above 90º. The stopper has a glide force variation less than about 1.3 N when calculated according to the Glide Force Variation test method described herein. In some embodiments, the