

Plasma Coating Technology Overview

A. Plasma Coating Deposition

The new plasma coating technology discussed herein is based on Plasma Enhanced Chemical Vapor Deposition (PECVD). The process utilizes a silicon containing vapor that can be combined with oxygen at reduced pressures (mTorr range – atmospheric pressure is 760 Torr) inside a blood tube or syringe. An electrical field generated at 13.56MHz [radio frequency range] is then applied between an external electrode and an internal grounded gas inlet to create a plasma. At the pressures and powers that are used to coat tubes and syringes, the plasma process is driven by electron impact ionization, which means the electrons in the process are the driving force behind the chemistry. Specifically, the plasma drives the chemical reaction through electron impact ionization of the silicon containing material [hexamethyldisiloxane (HMDSO and other reactants like octamethylcyclotetrasiloxane octamethylcyclotetrasiloxane (OMCTS)] resulting in a silicon dioxide or SiO_xCyHz coating deposited onto the interior surfaces of the tube or syringe. These coatings are on the order of 20 or more nanometers in thickness. HMDSO consists of an Si-O-Si backbone with six (6) methyl groups attached to the silicon atoms. The process breaks the Si-C bonds and (at the surface of the tube or syringe) reacts with oxygen to create silicon dioxide. Since the coating is grown on an atomic basis, dense, conformal coatings with thicknesses of 20-30 nanometers can achieve significant barrier properties. The silicon oxide acts as a physical barrier to gases, moisture, and small organic molecules, and is of greater purity than commercial glasses. OMCTS results in coatings with lubricity or anti-adhesion properties.

The new technology is unique in several aspects:

1. The process utilizes the rigid container as the vacuum chamber. PECVD conventionally uses a secondary vacuum vessel into which the part(s) are loaded and coated. Utilizing the container as a vacuum chamber significantly simplifies the process apparatus and reduces cycle/processing time, and thus manufacturing cost and capital. This approach also reduces scale-up issues since scale-up is as simple as replicating the number of tubes or syringes required to meet the throughput requirements.

2. Radio Frequency excitation of the plasma allows energy to be imparted to the ionized gas with little heating of the part. Unlike microwave excitation energies, typically used in PECVD, which will impart significant energy to water molecules in the part itself, radio frequency will not preferentially heat the polymeric tubes or syringes. Controlled heat absorption is critical to prevent substrate temperature increases approaching plastic glass transition temperatures, causing loss of dimensional integrity (collapse under vacuum).
3. Single layer gas barrier coating – the new technology utilizes a single layer of silicon dioxide directly on the interior surface of the part. Most other barrier technologies (thin film) require at least two layers.
4. Combination barrier-lubricity coatings – the new technology utilizes a combination silicon dioxide/SiOxCyHz coating to provide multiple performance attributes (barrier/lubricity).
5. Gas inlet/electrode configuration – the highly asymmetric design helps to prolong the gas inlet life.

The plasma deposition technology utilizes a simple manufacturing configuration. The system is based on a “puck,” which is used in transportation of tubes and syringes in and out of the coating station. The device-puck interface (see Figures 1 and 2, below) is critical, since once coating/characterization conditions are established at the pilot scale, there are no scaling issues when moving to full scale production; one simply increases the number of pucks through the same process. The puck is manufactured from a polymeric material (e.g. Delrin™) to provide an electrically insulated base. The tube and syringe are mounted into the puck with the largest opening sealing against an o-ring (mounted in the puck itself). The o-ring provides the vacuum seal between the part and the puck so that the ambient air (principally nitrogen and oxygen with some water vapor) can be removed (pressure reduced) and the process gases introduced. The puck has several key features in addition to the o-ring seal. The puck provides a means of connection to the vacuum pump (which pumps away the atmospheric gases and the by-products of the silicon dioxide reaction), a means of accurately aligning the gas inlet in the part, and a means of providing a vacuum seal between the puck and gas inlet.

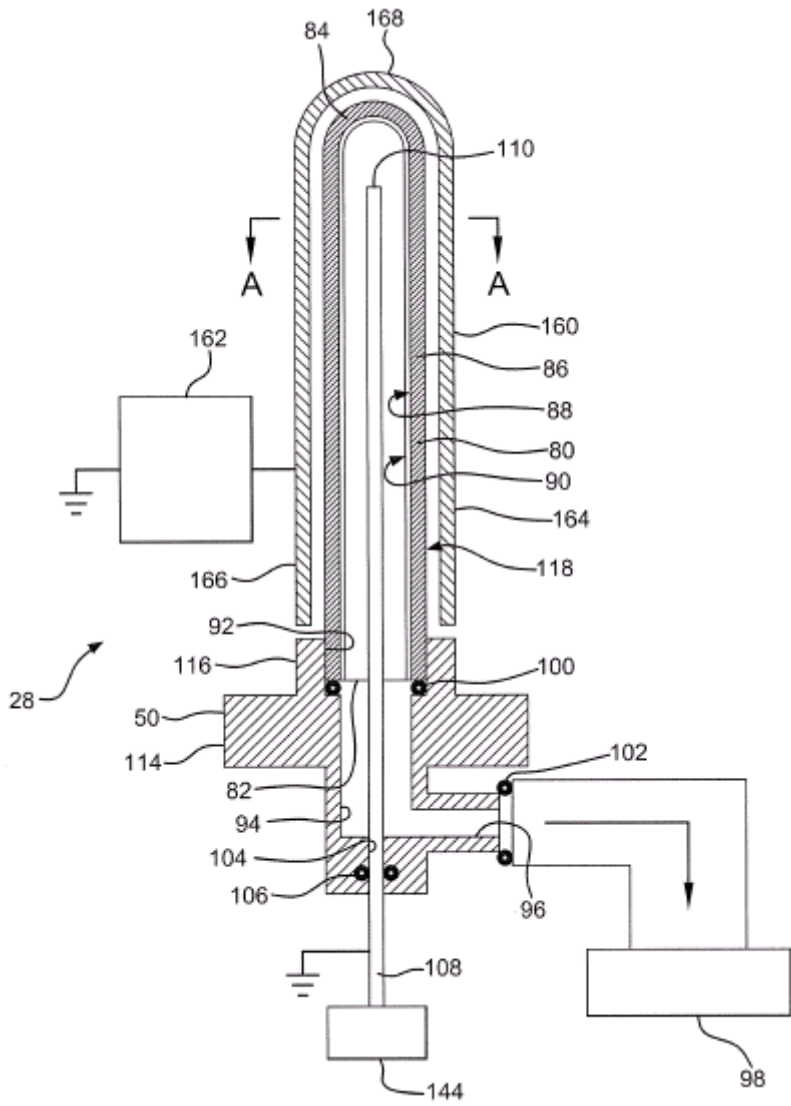


Figure 1. Blood Tube-Puck Coater Interface

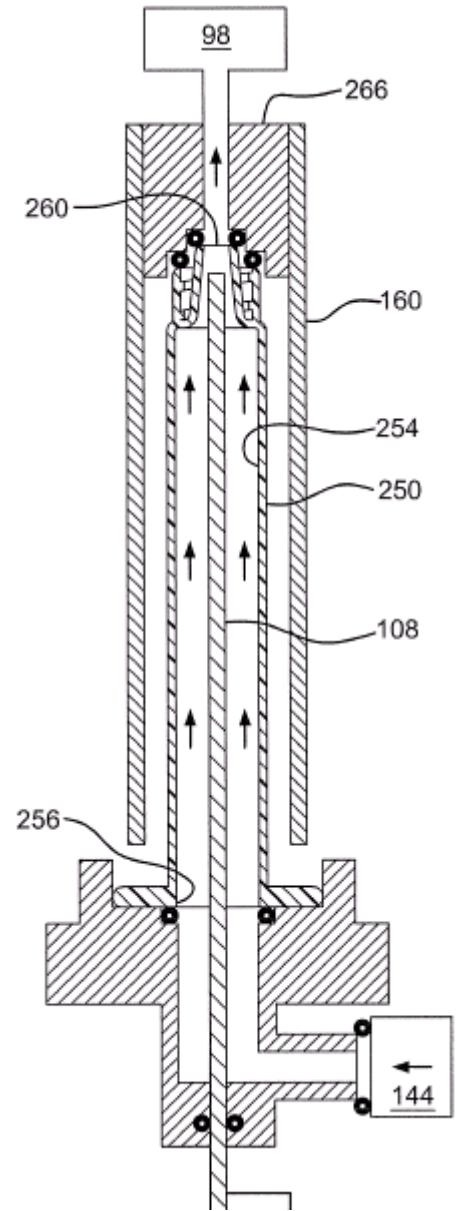


Figure 2. Syringe Barrel-Puck Coater Interface

Reference characters used in
 Figures 1 and 2:

20 Vessel processing system
 22 Injection molding machine
 24 Visual inspection station
 26 Leak check station (pre-coating)
 28 Coating station
 30 Leak check station (post-coating)
 32 Optical source transmission station (thickness)
 34 Optical source transmission station (defects)
 36 Output
 38 Vessel holder
 40 Vessel holder
 42 Vessel holder
 44 Vessel holder
 46 Vessel holder
 48 Vessel holder
 50 Vessel holder
 52 Vessel holder
 54 Vessel holder
 56 Vessel holder
 58 Vessel holder
 60 Vessel holder
 62 Vessel holder
 64 Vessel holder
 66 Vessel holder
 68 Vessel holder
 70 Conveyor
 72 Transfer mechanism (on)
 74 Transfer mechanism (off)
 80 Vessel
 82 Opening
 84 Closed end
 86 Wall
 88 Interior surface
 90 Barrier coating
 92 Vessel port
 94 Vacuum duct
 96 Vacuum port
 98 Vacuum source
 100 O-ring seal (of 92)
 102 O-ring seal (of 96)
 104 Gas inlet port
 106 O-ring seal (of 100)
 108 Probe (electrode)
 110 Gas delivery port (of 108)
 112 Vessel holder (Fig. 3)
 114 Housing (of 50 or 112)
 116 Collar
 118 Exterior surface (of 80)
 120 Vessel holder (array)
 122 Vessel port (Fig. 4)
 130 Frame (Fig. 5)
 132 Light source
 134 Side channel
 136 Shut-off valve
 138 Probe port
 140 Vacuum port
 142 PECVD gas inlet port
 144 PECVD gas source
 146 Vacuum line (to 98)
 148 Shut-off valve
 150 Flexible line (of 134)
 152 Pressure gauge
 154 Interior of vessel 80
 160 Electrode
 162 Power supply
 164 Sidewall (of 160)
 166 Sidewall (of 160)
 168 Closed end (of 160)
 170 Light source (Fig. 10)
 172 Detector
 174 Pixel (of 172)
 176 Interior surface (of 172)
 182 Aperture (of 186)
 184 Wall (of 186)
 186 Integrating sphere
 190 Microwave power supply
 192 Waveguide
 194 Microwave cavity
 196 Gap
 198 Top end (of 194)
 200 Electrode
 202 Tube transport
 204 Suction cup
 208 Mold core
 210 Mold cavity
 212 Mold cavity liner
 220 Bearing surface (Fig. 2)
 222 Bearing surface (Fig. 2)
 224 Bearing surface (Fig. 2)
 226 Bearing surface (Fig. 2)
 228 Bearing surface (Fig. 2)
 230 Bearing surface (Fig. 2)
 232 Bearing surface (Fig. 2)
 234 Bearing surface (Fig. 2)
 236 Bearing surface (Fig. 2)
 238 Bearing surface (Fig. 2)
 240 Bearing surface (Fig. 2)
 250 Syringe barrel
 252 Syringe
 254 Interior surface (of 250)
 256 Back end (of 250)
 258 Plunger (of 252)
 260 Front end (of 250)
 262 Cap
 264 Interior surface (of 262)
 266 Fitting
 268 Vessel
 270 Closure
 272 Interior facing surface
 274 Lumen
 276 Wall-contacting surface
 278 Inner surface (of 280)
 280 Vessel wall
 282 Stopper
 284 Shield
 286 Lubricating layer
 288 Barrier layer
 290 Apparatus for coating, e.g., 250
 292 Inner surface (of 294)
 294 Restricted opening (of 250)
 296 Processing vessel
 298 Outer surface (of 250)
 300 Lumen (of 250)
 302 Larger opening (of 250)
 304 Processing vessel lumen
 306 Processing vessel opening
 308 Inner electrode
 310 Interior passage (of 308)
 312 Proximal end (of 308)
 314 Distal end (of 308)
 316 Distal opening (of 308)
 318 Plasma
 320 Vessel support
 322 Port (of 320)
 324 Processing vessel (conduit type)
 326 Vessel opening (of 324)
 328 Second opening (of 324)
 330 Vacuum port (receiving 328)

For SiO₂ deposition, HMDSO and oxygen gases are then admitted into the container through the grounded gas inlet which extends up into the part. At this point, the puck and container are moved into the electrode area. The electrode is constructed from a conductive material (for example copper) and provides a tunnel through which the part passes. The electrode does not make physical contact with the container or the puck and is supported independently. An RF impedance matching network and power supply are connected directly to the electrode. The power supply provides energy (at 13.56MHz) to the impedance matched network. The RF matching network acts to match the output impedance of the power supply to the complex (capacitive and inductive) impedance of the ionized gases. The matching network delivers maximum power delivery to the ionized gas which ensures deposition of the silicon dioxide coating.

Once the container is coated (as the puck moves the container through the electrode channel – which is stationary), the gases are stopped and atmospheric air (or pure nitrogen) is allowed inside the puck/container to bring it back to atmospheric pressure. At this time, the container can be removed from the puck and moved to the next processing station.

The above describes clearly the means of coating a blood tube, parenteral vial or ampule. Syringes require an additional step before and after loading onto the puck. Since the syringes have opening at both ends (one for connection to a needle and the second for installation of a plunger), the needle end must be sealed prior to coating. The above process allows reaction gases to be admitted into the plastic part interior, an electrical current to pass through the gas inside of the part and a plasma to be established inside the part. The plasma (an ionized composition of the HMDSO or OMCTS and oxygen gases) is what drives the chemistry and the deposition of the plasma coating.

B. Product Specifications/ Plasma-Coated Plastic Evacuated Blood Collection Tubes

It is established in the evacuated blood collection tube (“tubes”) industry that plastic tube replacement of glass tubes in the mid-1980’s was driven by the improved safety benefits of plastic tubes. While eliminating glass tube breakage and reducing blood exposure to phlebotomists, analysts, and patients, plastic tubes did not, and currently do not, match glass tubes in almost all medical performance categories. It is the purpose of this plasma-coated tube technology (“plasma coating”) to impart

significantly improved performance relative to incumbent plastic tubes , and in some key areas, match (or exceed) glass tube performance.

Incumbent tubes are predominantly comprised of injection-molded grade polyethylene terephthalate (PET) plastic in sizes 13x75mm, 13x100mm, and 16x100mm. Some tubes (containing sodium citrate additives) are PET/PP multilayer compositions for purposes of improved moisture retention, and a minor number of glass tubes are still required for trace metal analysis due to unacceptable performance of plastic tubes. The plasma coating technology will replace the current tube market (Glass, PET,) with a single plasma-coated PET tube composition offering for all evacuated blood tube products. For the sodium citrate tube, a glass tube or a 2-walled PET/PP tube is currently used in the marketplace. These tubes will be replaced with a single plasma-coated COC or PP tube composition.

A compromise in plastic tube versus glass tube performance relates to maintenance of partial vacuum inside the tube assemblies, which is required to maintain appropriate blood draw volumes critical to accurate blood analysis. Based on NCCLS standards, when an evacuated blood tube loses 10% of its initial blood draw capability, it is considered unacceptable for use and should be discarded. PET (or PET/PP)-based tubes typically claim a shelf life of 6-18 months from manufacture. Glass tubes, with their improved gas barrier performance, claim a shelf life of 24-36 months. The plasma coating technology has been shown to extend the shelf life of PET-based tubes to 24-36 months, matching the glass standard. Using accelerated aging methods, a 36-month shelf life has been demonstrated with plasma coated tubes.

PET is synthesized via condensation polymerization of terephthalic acid and ethylene glycol using antimony or titanium catalysts. While present in low levels, these metals have potential to interfere with trace metal analysis. Additionally, all PET contains varying trace levels of acetaldehyde, which has been demonstrated to migrate into aqueous fluid media from the plastic. With plasma coating technology, the SiO₂ coating, derived entirely from non-metal gaseous precursors [hexamethyldisiloxane (HMDSO)], will itself contain no trace metals and function as a barrier to trace metals and organic solutes potentially leaching from the PET into the additives or blood in the tubes. In addition to control of leaching from PET tubes, the same plasma coating technology offers potential to provide a solute barrier for the tube closure, typically an elastomeric plastic composition containing even higher levels of leachable organic oligomers and catalysts.

A negative effect of polymeric surfactant, used in PET plastic tubes for surface wetting, is the presence of low molecular weight oligomers (from polymeric surfactant synthesis). These oligomers can leach into the blood sample (as determined by MALDI-ToFS oligomer analysis) and can affect subsequent clinical analysis. Thus, the use of polymeric surfactants with PET tubes can result in oligomer contamination. The plasma coating technology will provide a glass-like hydrophilic, SiO₂ surface on PET offering good wettability and low wall shear blood hemolysis potential without generating issues relating to polymeric surfactant oligomer leaching.

Physical analysis of saline-tube extracts using ICP-MS (total extractible elemental silicon analysis) have validated ~~no~~ minimal elemental silicon extraction from the SiO₂ plasma coating. Subsequent clinical analysis studies will validate these physical improvements.

Table 1 (Appendix) summarizes the incumbent product issues, plasma coating technology improvements, and impact to evacuated blood collection tube devices.

B. Product Specifications/ Plasma-Coated Plastic Vials and Pre-fill Syringes

The PECVD coating can be applied to plastic-injectable drug packaging to provide a gas barrier and solute barrier for the drug product.

Vials are small vessels or bottles, especially used to store medication as liquids, powders or lyophilized powders. They can also be sample vessels e.g. for use in autosampler devices in analytical chromatography. A vial can have a tubular shape or a bottle-like shape with a neck. The bottom is usually flat unlike test tubes or sample collection tubes which usually have a rounded bottom. Vials can be made, for example, of plastic (e.g. polypropylene, COC, COP).

Syringes, comprising a barrel holding fluid (for example volumes of 2-20 milliliters) with a capillary neck to permit injection needle attachment, are used for administration of synthetic and biological drugs and pharmaceuticals. Historically, syringes have been all glass construction to leverage glass' inertness and barrier performance. Glass barrel/plunger combinations are highly precision machined, so as to prevent leakage, and expensive to manufacture. Driven by cost reduction, plastic plungers comprising a PP plunger with an elastomeric tip have replaced glass plungers, but glass barrels are still the standard, mainly due to concerns over the lack of inertness and barrier performance of plastic barrels for synthetic or biological drug stability.

Separately, issues of trace metal and oxide interaction of glass syringe leachants with biological drugs has warranted consideration of alternative injectable packaging materials. There is a significant market opportunity [cost, weight, and safety (from breakage)] and payload stability to provide a plastic-based package that demonstrates acceptable inertness and barrier performance for the injectable drug market. It is a purpose of this plasma-coated tube technology ("plasma coating") to provide a plasma-coated plastic package, replacing glass packaging for injectable or other liquid drugs, resulting in lower cost, reduced weight, and safer products for the marketplace.

Table 2 (Appendix) lists injectable and other liquid drugs for which the use of plasma-coated plastic packaging is contemplated.

Table 3 (Appendix) lists diagnostic test for which plasma-coated plastic vessels can be used for sample retention.

With utilization of elastomeric-tipped PP plungers and glass barrel syringes, a thick (ca 400+ nanometer) silicone coating is required to reduce both “sticking” friction [resulting from elastomeric and glass contact over time] as well as “sliding” friction during payload injection. Low molecular weight silicones are carried with the payload and delivered into the patient. Efforts to provide a high lubricity, low leachable equivalent have not been realized in the marketplace. It is the purpose of this plasma-coated tube technology (“plasma coating”) to provide a plasma coated plastic syringe barrel offering high lubricity, low leachable performance. Work to date indicates use of octamethylcyclotetrasiloxane (OMCTS) plasma-polymerized coatings offers comparable lubricity to silicones. Leaching studies are underway and indicate equal or lower silicone-based extractables than with either HMDSO-based lubricity coatings or traditional silicone coatings.

For glass syringes, various types of glass have been utilized, including soda glass and borosilicate-type glasses. These glasses, alloys of silica (SiO_2) and other metal oxides, can leach metal ions into the syringe fluid contents, affecting the payload stability. Separately, formation of the capillary annulus is accomplished via hot metal wire insertion through the solid capillary. The hot metal wire leaves trace metal residues on the glass which can also affect fluid content stability. In contrast, plasma coating technology utilizes gaseous silicon precursors depositing a metal-free silica or silicon-based coating. The plasma coating technology applied to molded plastic syringe barrels will eliminate traditional glass-based metal contamination issues. ICP-MS measurement of SiO_x -coated COC syringe barrels indicates none of the elemental extractables observed with glass syringe barrels.

A concern of converting from glass to plastic syringes centers around the potential for leachable materials from plastics. With plasma coating technology, the coating, being derived from non-metal gaseous precursors e.g. HMDSO, will itself contain no trace metals and function as a barrier to inorganic, metals and organic solutes, preventing leaching of these species from the PET into syringe fluids.

Certain syringes prefilled with synthetic and biological pharmaceutical formulations are very oxygen and moisture sensitive. A critical factor in the conversion from glass to plastic syringe barrels will be the improvement of plastic oxygen and moisture barrier performance. The plasma coating technology

is targeted to provide greater improvement in oxygen barrier COC packages. Additional increases in oxygen and moisture barrier performance may be realized combining compatible plasma barrier coatings with other barrier improvement technologies including multilayer, multi-component two-shot syringe compositions and external barrier coatings such as Saran films.

Coated Stoppers and Plungers

A plasma enhanced vapor deposition (PECVD) process has been used for coating rubber stoppers and plunger components that are used in injectable drug packaging (ex. vials, syringes and auto injector cartridges). The process applies a very thin coating of SiOx to the drug contact surfaces of rubber packaging elements. The SiOx coating on the rubber prevents materials from leaching into the drug. In addition, the SiOx coating improves the gas barrier to water and oxygen. The coating is applied selectively, on rubber stoppers and plungers along the areas that are in direct contact with the injectable drug. Since the coating is applied selectively, the coating does not alter the sealing surface, or in the case of syringes, the plunger interaction (movement) with the syringe. Tests are currently being conducted to demonstrate the effectiveness and robustness of the coating to withstand all aspects of injectable drug packaging.

The system approach described herein of plasma coating the plastic container body and rubber components of the injectable drug package provides an inert (pure glass) drug contact surface with significantly improved gas barrier properties, low leaching and lubricity performance; a combination not realized in incumbent products.

Table 4 (Appendix) summarizes the incumbent product issues, and plasma coating technology improvements and impact on prefilled syringe barrel devices.

C. In-line Process Coating Validation Methods

For several years, plasma coating technology has been commercially applied to 2D plastic films and 3D plastic containers to improve plastic moisture, oxygen, and carbon dioxide barrier performance, in the food and beverage packaging markets. While 2D plasma coated plastic laminate processes have incorporated optical interference-based thickness measurements as an on-line quality control measure of coating thickness, little on-line development of coating thickness has been realized with beverage containers; instead periodic offline sampling is the norm.

The screening criterion applied in the evaluation and incorporation of in-line coating validation methods for blood tubes and syringe barrels are:

- (1) fast [less than 30 seconds (desirably much faster) to accommodate the fast production rates (300+ articles per minute)].
- (2) non-destructive (coating/article interrogation without modification).
- (3) coating distinguishable [must be able to determine presence (or absence) of 20-40 nanometer thick coating].
- (4) correlated to physical or clinical attribute.
- (5) available or adaptable to a commercial on-line process (cost effective and adaptable to continuous line operation).
- (6) sufficient measurement precision (from one or more methods) to have an alpha risk (allowing out of specification product to pass) equivalent to a six-sigma level of quality, while still maintaining a low enough beta risk (rejecting in-specification product) to be commercially acceptable.

Many methods have been screened (Table 5). The approach which currently best addresses all of these criterion utilizes Microflow Technology (Table 5, A3; Figure 3). Microflow Technology and sensors demonstrate sensitivity similar to helium detection approaches (mass spectrometry), typically starting from 5×10^{-7} standard cc/ second using only **air**. High sensitivity coupled with fast discrimination offers excellent methodology for coated article verification (Figure 4). Additionally, this

same method can be utilized for traditional leak detection after final product packaging. Work with this kinetic degassing approach is continuing to both correlate with established (but slow) equilibrium oxygen and moisture permeation methods and shorter coating assessment times, currently in the 5-10 one-to-five second range. Enhanced signal sensitivity has been realized through plastic imbibation and detection of gases (e.g. carbon dioxide) for plastics with inherently low gas solubilities.

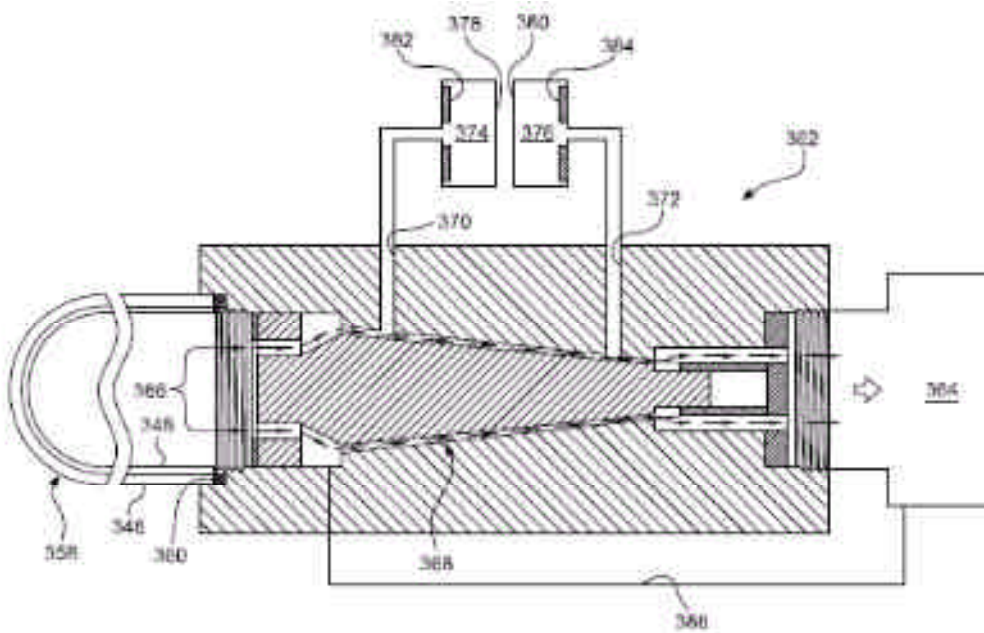


Figure 3. Microflow device and pressure sensors

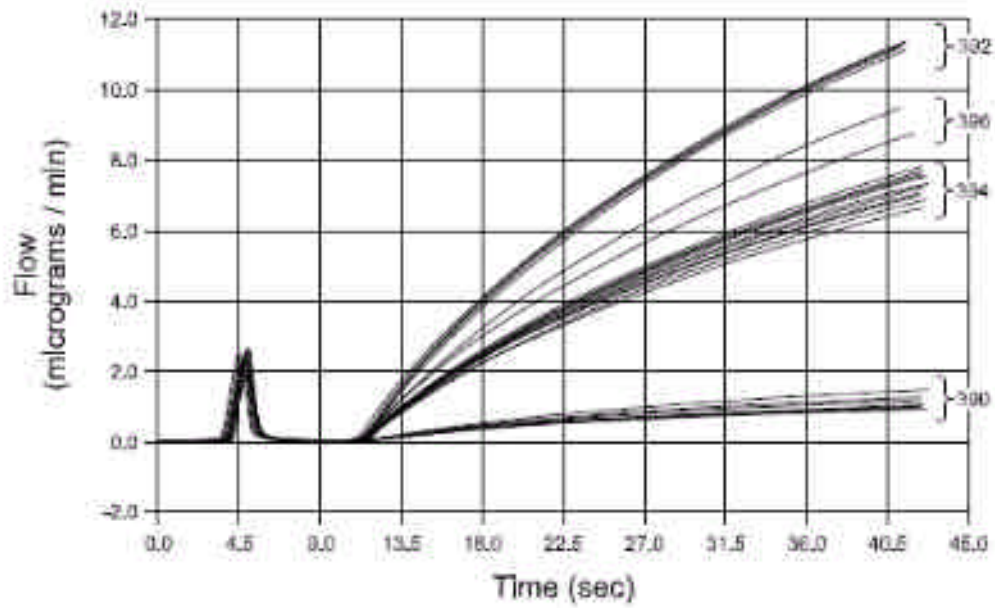


Figure 4. Flow differentiation of uncoated- (392), SiOx coated-(394), poorly coated- (394) PET blood tubes using Microflow technology.

Appendix

Table 1. Evacuated Blood Collection Tube Devices: Incumbent Product Issues, Plasma Coating Technology Improvements and Impact.

Incumbent Product (plastic tube device) Issues	Plasma Technology Improvement	Impact
Blood tube compositions comprise PET plastic, PET/PP laminate plastics, and glass	20-40 nanometer thick SiO ₂ -coated PET tubes provide a uniform glass-like interface to all additives and blood	Single raw material base for complete product line, reducing raw material inventory, production, and recycle cost
Citrate-containing tubes require multiwall tubes (PET/PP) to provide sufficient moisture barrier.	Plasma coating compositions amorphous carbon may reduce moisture permeability rates 50-100%	A plasma-coated plastic composition will reduce production costs.
Multiple composition tubes (multiple shot injection or shrink laminates) are difficult to recycle	20-40 nanometer thick SiO ₂ -coated PET tubes are recyclable	100 percent raw material utilization (zero waste) will reduce costs

Table 2. Potential Drug Candidates for Plasma-Coated Plastic Packaging.

The lists provided in this table constitute examples of drugs and drug types for which the use of plasma-coated packaging can be used. It should be understood that these lists are non-exhaustive and intended as exemplary only. The use of plasma-coated packaging is contemplated for all drug types, and implementation of the plasma coating technology described above in packaging of drugs not appearing in the lists below would be a matter of routine experimentation.

Some of the drugs listed below appear using generic terminology or chemical names, while some appear using trade names. It should be understood that where generic or chemical terminology is used, all drugs falling within the generic class and having different trade names are intended to be included as well. Likewise, where a drug appears using a trade name, all drugs falling within the class and having different trade names are intended to be included as well.

2.1 Injectable Drugs

Ablavar (Gadofosveset Trisodium Injection)
Abarelis Depot
Abobotulinumtoxin A Injection (Dysport)
ABT-263
ABT-869
ABX-EFG
Accretropin (Somatropin Injection)
Acetadote (Acetylcysteine Injection)
Acetazolamide Injection (Acetazolamide Injection)
Acetylcysteine Injection (Acetadote)
Actemra (Tocilizumab Injection)
Acthrel (Corticotropin Ovine Triflutate for Injection)
Actummune
Activase
Acyclovir for Injection (Zovirax Injection)
Adacel
Adalimumab
Adenoscan (Adenosine Injection)
Adenosine Injection (Adenoscan)
Adrenaclick
AdreView (Iobenguane I 123 Injection for Intravenous Use)

Afluria
Ak-Fluor (Fluorescein Injection)
Aldurazyme (Laronidase)
Alglucerase Injection (Ceredase)
Alkeran Injection (Melphalan Hcl Injection)
Allopurinol Sodium for Injection (Aloprim)
Aloprim (Allopurinol Sodium for Injection)
Alprostadiil
Alsuma (Sumatriptan Injection)
ALTU-238
Amino Acid Injections
Aminosyn
Apidra
Apremilast
Alprostadiil Dual Chamber System for Injection (Caverject Impulse)
AMG 009
AMG 076
AMG 102
AMG 108
AMG 114
AMG 162
AMG 220
AMG 221
AMG 222
AMG 223
AMG 317
AMG 379
AMG 386
AMG 403
AMG 477
AMG 479
AMG 517
AMG 531
AMG 557

AMG 623
AMG 655
AMG 706
AMG 714
AMG 745
AMG 785
AMG 811
AMG 827
AMG 837
AMG 853
AMG 951
Amiodarone HCl Injection (Amiodarone HCl Injection)
Amobarbital Sodium Injection (Amytal Sodium)
Amytal Sodium (Amobarbital Sodium Injection)
Anakinra
Anti-Abeta
Anti-Beta7
Anti-Beta20
Anti-CD4
Anti-CD20
Anti-CD40
Anti-IFNalpha
Anti-IL13
Anti-OX40L
Anti-oxLDS
Anti-NGF
Anti-NRP1
Arixtra
Amphadase (Hyaluronidase Inj)
Ammonul (Sodium Phenylacetate and Sodium Benzoate Injection)
Anaprox
Anzemet Injection (Dolasetron Mesylate Injection)
Apidra (Insulin Glulisine [rDNA origin] Inj)
Apomab

Aranesp (darbepoetin alfa)
Argatroban (Argatroban Injection)
Arginine Hydrochloride Injection (R-Gen 10)
Aristocort
Aristospan
Arsenic Trioxide Injection (Trisenox)
Articane HCl and Epinephrine Injection (Septocaine)
Arzerra (Ofatumumab Injection)
Asclera (Polidocanol Injection)
Ataluren
Ataluren-DMD
Atenolol Inj (Tenormin I.V. Injection)
Atracurium Besylate Injection (Atracurium Besylate Injection)
Avastin
Azactam Injection (Aztreonam Injection)
Azithromycin (Zithromax Injection)
Aztreonam Injection (Azactam Injection)
Baclofen Injection (Lioresal Intrathecal)
Bacteriostatic Water (Bacteriostatic Water for Injection)
Baclofen Injection (Lioresal Intrathecal)
Bal in Oil Ampules (Dimercaprol Injection)
BayHepB
BayTet
Benadryl
Bendamustine Hydrochloride Injection (Treanda)
Benztropine Mesylate Injection (Cogentin)
Betamethasone Injectable Suspension (Celestone Soluspan)
Bexxar
Bicillin C-R 900/300 (Penicillin G Benzathine and Penicillin G Procaine Injection)
Blenoxane (Bleomycin Sulfate Injection)
Bleomycin Sulfate Injection (Blenoxane)
Boniva Injection (Ibandronate Sodium Injection)
Botox Cosmetic (OnabotulinumtoxinA for Injection)
BR3-FC

Bravelle (Urofollitropin Injection)
Bretylum (Bretylum Tosylate Injection)
Brevital Sodium (Methohexital Sodium for Injection)
Brethine
Briobacept
BTT-1023
Bupivacaine HCl
Byetta
Ca-DTPA (Pentetate Calcium Trisodium Inj)
Cabazitaxel Injection (Jevtana)
Caffeine Alkaloid (Caffeine and Sodium Benzoate Injection)
Calcijex Injection (Calcitrol)
Calcitrol (Calcijex Injection)
Calcium Chloride (Calcium Chloride Injection 10%)
Calcium Disodium Versenate (Edetate Calcium Disodium Injection)
Campath (Altemtuzumab)
Camptosar Injection (Irinotecan Hydrochloride)
Canakinumab Injection (Ilaris)
Capastat Sulfate (Capreomycin for Injection)
Capreomycin for Injection (Capastat Sulfate)
Cardiolite (Prep kit for Technetium Tc99 Sestamibi for Injection)
Carticel
Cathflo
Cefazolin and Dextrose for Injection (Cefazolin Injection)
Cefepime Hydrochloride
Cefotaxime
Ceftriaxone
Cerezyme
Carnitor Injection
Caverject
Celestone Soluspan
Celsior
Cerebyx (Fosphenytoin Sodium Injection)
Ceredase (Alglucerase Injection)

Ceretec (Technetium Tc99m Exametazime Injection)
Certolizumab
CF-101
Chloramphenicol Sodium Succinate (Chloramphenicol Sodium Succinate Injection)
Chloramphenicol Sodium Succinate Injection (Chloramphenicol Sodium Succinate)
Cholestigel (Colestevlam HCL)
Choriogonadotropin Alfa Injection (Ovidrel)
Cimzia
Cisplatin (Cisplatin Injection)
Clolar (Clofarabine Injection)
Clomiphine Citrate
Clonidine Injection (Duraclon)
Cogentin (Benztropine Mesylate Injection)
Colistimethate Injection (Coly-Mycin M)
Coly-Mycin M (Colistimethate Injection)
Compath
Conivaptan Hcl Injection (Vaprisol)
Conjugated Estrogens for Injection (Premarin Injection)
Copaxone
Corticotropin Ovine Triflutate for Injection (Acthrel)
Corvert (Ibutilide Fumarate Injection)
Cubicin (Daptomycin Injection)
CF-101
Cyanokit (Hydroxocobalamin for Injection)
Cytarabine Liposome Injection (DepoCyt)
Cyanocobalamin
Cytovene (ganciclovir)
D.H.E. 45
Dacetuzumab
Dacogen (Decitabine Injection)
Dalteparin
Dantrium IV (Dantrolene Sodium for Injection)
Dantrolene Sodium for Injection (Dantrium IV)
Daptomycin Injection (Cubicin)

Darbepoietin Alfa
DDAVP Injection (Desmopressin Acetate Injection)
Decavax
Decitabine Injection (Dacogen)
Dehydrated Alcohol (Dehydrated Alcohol Injection)
Denosumab Injection (Prolia)
Delatestryl
Delestrogen
Delteparin Sodium
Depacon (Valproate Sodium Injection)
Depo Medrol (Methylprednisolone Acetate Injectable Suspension)
DepoCyt (Cytarabine Liposome Injection)
DepoDur (Morphine Sulfate XR Liposome Injection)
Desmopressin Acetate Injection (DDAVP Injection)
Depo-Estradiol
Depo-Provera 104mg/ml
Depo-Provera 150mg/ml
Depo-Testosterone
Dexrazoxane for Injection, Intravenous Infusion Only (Totect)
Dextrose / Electrolytes
Dextrose and Sodium Chloride Inj (Dextrose 5% in 0.9% Sodium Chloride)
Dextrose
Diazepam Injection (Diazepam Injection)
Digoxin Injection (Lanoxin Injection)
Dilaudid-HP (Hydromorphone Hydrochloride Injection)
Dimercaprol Injection (Bal in Oil Ampules)
Diphenhydramine Injection (Benadryl Injection)
Dipyridamole Injection (Dipyridamole Injection)
DMOAD
Docetaxel for Injection (Taxotere)
Dolasetron Mesylate Injection (Anzemet Injection)
Doribax (Doripenem for Injection)
Doripenem for Injection (Doribax)
Doxercaliferol Injection (Hectorol Injection)

Doxil (Doxorubicin Hcl Liposome Injection)
Doxorubicin Hcl Liposome Injection (Doxil)
Duraclon (Clonidine Injection)
Duramorph (Morphine Injection)
Dysport (Abobotulinumtoxin A Injection)
Ecallantide Injection (Kalbitor)
EC-Naprosyn (naproxen)
Edetate Calcium Disodium Injection (Calcium Disodium Versenate)
Edex (Alprostadil for Injection)
Engerix
Edrophonium Injection (Enlon)
Eliglustat Tartate
Eloxatin (Oxaliplatin Injection)
Emend Injection (Fosaprepitant Dimeglumine Injection)
Enalaprilat Injection (Enalaprilat Injection)
Enlon (Edrophonium Injection)
Enoxaparin Sodium Injection (Lovenox)
Eovist (Gadoxetate Disodium Injection)
Enbrel (etanercept)
Enoxaparin
Epicel
Epinephrine
Epipen
Epipen Jr.
Epratuzumab
Erbitux
Ertapenem Injection (Invanz)
Erythropoietin
Essential Amino Acid Injection (Nephramine)
Estradiol Cypionate
Estradiol Valerate
Etanercept
Exenatide Injection (Byetta)
Evlotra

Fabrazyme (Adalsidase beta)
Famotidine Injection
FDG (Fludeoxyglucose F 18 Injection)
Feraheme (Ferumoxytol Injection)
Feridex I.V. (Ferumoxides Injectable Solution)
Fertinex
Ferumoxides Injectable Solution (Feridex I.V.)
Ferumoxytol Injection (Feraheme)
Flagyl Injection (Metronidazole Injection)
Fluarix
Fludara (Fludarabine Phosphate)
Fludeoxyglucose F 18 Injection (FDG)
Fluorescein Injection (Ak-Fluor)
Follistim AQ Cartridge (Follitropin Beta Injection)
Follitropin Alfa Injection (Gonal-f RFF)
Follitropin Beta Injection (Follistim AQ Cartridge)
Folotyn (Pralatrexate Solution for Intravenous Injection)
Fondaparinux
Forteo (Teriparatide (rDNA origin) Injection)
Fostamatinib
Fosaprepitant Dimeglumine Injection (Emend Injection)
Foscarnet Sodium Injection (Foscavir)
Foscavir (Foscarnet Sodium Injection)
Fosphenytoin Sodium Injection (Cerebyx)
Fospropofol Disodium Injection (Lusedra)
Fragmin
Fuzeon (enfuvirtide)
GA101
Gadobenate Dimeglumine Injection (Multihance)
Gadofosveset Trisodium Injection (Ablavar)
Gadoteridol Injection Solution (ProHance)
Gadoversetamide Injection (OptiMARK)
Gadoxetate Disodium Injection (Eovist)
Ganirelix (Ganirelix Acetate Injection)

Gardasil
GC1008
GDFD
Gemtuzumab Ozogamicin for Injection (Mylotarg)
Genotropin
Gentamicin Injection
GENZ-112638
Golimumab Injection (Simponi Injection)
Gonal-f RFF (Follitropin Alfa Injection)
Granisetron Hydrochloride (Kytril Injection)
Gentamicin Sulfate
Glatiramer Acetate
Glucagen
Glucagon
HAE1
Haldol (Haloperidol Injection)
Havrix
Hectorol Injection (Doxercalciferol Injection)
Hedgehog Pathway Inhibitor
Heparin
Herceptin
hG-CSF
Humalog
Human Growth Hormone
Humatrope
HuMax
Humegon
Humira
Humulin
Ibandronate Sodium Injection (Boniva Injection)
Ibuprofen Lysine Injection (NeoProfen)
Ibutilide Fumarate Injection (Corvert)
Idamycin PFS (Idarubicin Hydrochloride Injection)
Idarubicin Hydrochloride Injection (Idamycin PFS)

Ilaris (Canakinumab Injection)
Imipenem and Cilastatin for Injection (Primaxin I.V.)
Imitrex
Incobotulinumtoxin A for Injection (Xeomin)
Increlex (Mecasermin [rDNA origin] Injection)
Indocin IV (Indomethacin Inj)
Indomethacin Inj (Indocin IV)
Infanrix
Innohep
Insulin
Insulin Aspart [rDNA origin] Inj (NovoLog)
Insulin Glargine [rDNA origin] Injection (Lantus)
Insulin Glulisine [rDNA origin] Inj (Apidra)
Interferon alfa-2b, Recombinant for Injection (Intron A)
Intron A (Interferon alfa-2b, Recombinant for Injection)
Invanz (Ertapenem Injection)
Invega Sustenna (Paliperidone Palmitate Extended-Release Injectable Suspension)
Invirase (saquinavir mesylate)
Iobenguane I 123 Injection for Intravenous Use (AdreView)
Iopromide Injection (Ultravist)
Ioversol Injection (Optiray Injection)
Iplex (Mecasermin Rinfabate [rDNA origin] Injection)
Iprivask
Irinotecan Hydrochloride (Camptosar Injection)
Iron Sucrose Injection (Venofer)
Istodax (Romidepsin for Injection)
Itraconazole Injection (Sporanox Injection)
Jevtana (Cabazitaxel Injection)
Jonexa
Kalbitor (Ecallantide Injection)
KCL in D5NS (Potassium Chloride in 5% Dextrose and Sodium Chloride Injection)
KCL in D5W
KCL in NS
Kenalog 10 Injection (Triamcinolone Acetonide Injectable Suspension)

Kepivance (Palifermin)
Keppra Injection (Levetiracetam)
Keratinocyte
KFG
Kinase Inhibitor
Kineret (Anakinra)
Kinlytic (Urokinase Injection)
Kinrix
Klonopin (clonazepam)
Kytril Injection (Granisetron Hydrochloride)
Iacosamide Tablet and Injection (Vimpat)
Lactated Ringer's
Lanoxin Injection (Digoxin Injection)
Lansoprazole for Injection (Prevacid I.V.)
Lantus
Leucovorin Calcium (Leucovorin Calcium Injection)
Lente (L)
Leptin
Levemir
Leukine Sargramostim
Leuprolide Acetate
Levothyroxine
Levetiracetam (Keppra Injection)
Lovenox
Levocarnitine Injection (Carnitor Injection)
Lexiscan (Regadenoson Injection)
Lioresal Intrathecal (Baclofen Injection)
Liraglutide [rDNA] Injection (Victoza)
Lovenox (Enoxaparin Sodium Injection)
Lucentis (Ranibizumab Injection)
Lumizyme
Lupron (Leuprolide Acetate Injection)
Lusedra (Fospropofol Disodium Injection)
Maci

Magnesium Sulfate (Magnesium Sulfate Injection)
Mannitol Injection (Mannitol IV)
Marcaine (Bupivacaine Hydrochloride and Epinephrine Injection)
Maxipime (Cefepime Hydrochloride for Injection)
MDP Multidose Kit of Technetium Injection (Technetium Tc99m Medronate Injection)
Mecasermin [rDNA origin] Injection (Increlex)
Mecasermin Rinfabate [rDNA origin] Injection (Iplex)
Melphalan Hcl Injection (Akeran Injection)
Methotrexate
Menactra
Menopur (Menotropins Injection)
Menotropins for Injection (Repronex)
Methohexital Sodium for Injection (Brevital Sodium)
Methyldopate Hydrochloride Injection, Solution (Methyldopate Hcl)
Methylene Blue (Methylene Blue Injection)
Methylprednisolone Acetate Injectable Suspension (Depo Medrol)
MetMab
Metoclopramide Injection (Reglan Injection)
Metrodin (Urofollitropin for Injection)
Metronidazole Injection (Flagyl Injection)
Miacalcin
Midazolam (Midazolam Injection)
Mimpara (Cinaclet)
Minocin Injection (Minocycline Inj)
Minocycline Inj (Minocin Injection)
Mipomersen
Mitoxantrone for Injection Concentrate (Novantrone)
Morphine Injection (Duramorph)
Morphine Sulfate XR Liposome Injection (DepoDur)
Morrhuate Sodium (Morrhuate Sodium Injection)
Motesanib
Mozobil (Plerixafor Injection)
Multihance (Gadobenate Dimeglumine Injection)
Multiple Electrolytes and Dextrose Injection

Multiple Electrolytes Injection
Mylotarg (Gemtuzumab Ozogamicin for Injection)
Myozyme (Alglucosidase alfa)
Nafcillin Injection (Nafcillin Sodium)
Nafcillin Sodium (Nafcillin Injection)
Naltrexone XR Inj (Vivitrol)
Naprosyn (naproxen)
NeoProfen (Ibuprofen Lysine Injection)
Nandrol Decanoate
Neostigmine Methylsulfate (Neostigmine Methylsulfate Injection)
NEO-GAA
NeoTect (Technetium Tc 99m Depreotide Injection)
Nephramine (Essential Amino Acid Injection)
Neulasta (pegfilgrastim)
Neupogen (Filgrastim)
Novolin
Novolog
NeoRecormon
Neutrexin (Trimetrexate Glucuronate Inj)
NPH (N)
Nexterone (Amiodarone HCl Injection)
Norditropin (Somatropin Injection)
Normal Saline (Sodium Chloride Injection)
Novantrone (Mitoxantrone for Injection Concentrate)
Novolin 70/30 Innolet (70% NPH, Human Insulin Isophane Suspension and 30% Regular, Human Insulin Injection)
NovoLog (Insulin Aspart [rDNA origin] Inj)
Nplate (romiplostim)
Nutropin (Somatropin (rDNA origin) for Inj)
Nutropin AQ
Nutropin Depot (Somatropin (rDNA origin) for Inj)
Octreotide Acetate Injection (Sandostatin LAR)
Ocrelizumab
Ofatumumab Injection (Arzerra)
Olanzapine Extended Release Injectable Suspension (Zyprexa Relprevv)

Omnitarg
Omnitrope (Somatropin [rDNA origin] Injection)
Ondansetron Hydrochloride Injection (Zofran Injection)
OptiMARK (Gadoversetamide Injection)
Optiray Injection (Ioversol Injection)
Orencia
Osmitrol Injection in Aviva (Mannitol Injection in Aviva Plastic Container)
Osmitrol Injection in Viaflex (Mannitol Injection in Viaflex Plastic Container)
Osteoprotegerin
Ovidrel (Choriogonadotropin Alfa Injection)
Oxacillin (Oxacillin for Injection)
Oxaliplatin Injection (Eloxatin)
Oxytocin Injection (Pitocin)
Paliperidone Palmitate Extended-Release Injectable Suspension (Invega Sustenna)
Pamidronate Disodium Injection (Pamidronate Disodium Injection)
Panitumumab Injection for Intravenous Use (Vectibix)
Papaverine Hydrochloride Injection (Papaverine Injection)
Papaverine Injection (Papaverine Hydrochloride Injection)
Parathyroid Hormone
Paricalcitol Injection Fliptop Vial (Zemlar Injection)
PARP Inhibitor
Pedarix
PEGIntron
Peginterferon
Pegfilgrastim
Penicillin G Benzathine and Penicillin G Procaine
Pentetate Calcium Trisodium Inj (Ca-DTPA)
Pentetate Zinc Trisodium Injection (Zn-DTPA)
Pepcid Injection (Famotidine Injection)
Pergonal
Pertuzumab
Phentolamine Mesylate (Phentolamine Mesylate for Injection)
Physostigmine Salicylate (Physostigmine Salicylate (injection))
Physostigmine Salicylate (injection) (Physostigmine Salicylate)

Piperacillin and Tazobactam Injection (Zosyn)
Pitocin (Oxytocin Injection)
Plasma-Lyte 148 (Multiple Electrolytes Inj)
Plasma-Lyte 56 and Dextrose (Multiple Electrolytes and Dextrose Injection in Viaflex Plastic Container)
PlasmaLyte
Plerixafor Injection (Mozobil)
Polidocanol Injection (Asclera)
Potassium Chloride
Pralatrexate Solution for Intravenous Injection (Folotyn)
Pramlintide Acetate Injection (Symlin)
Premarin Injection (Conjugated Estrogens for Injection)
Prep kit for Technetium Tc99 Sestamibi for Injection (Cardiolite)
Prevacid I.V. (Lansoprazole for Injection)
Primaxin I.V. (Imipenem and Cilastatin for Injection)
Prochymal
Procrit
Progesterone
ProHance (Gadoteridol Injection Solution)
Prolia (Denosumab Injection)
Promethazine HCl Injection (Promethazine Hydrochloride Injection)
Propranolol Hydrochloride Injection (Propranolol Hydrochloride Injection)
Quinidine Gluconate Injection (Quinidine Injection)
Quinidine Injection (Quinidine Gluconate Injection)
R-Gen 10 (Arginine Hydrochloride Injection)
Ranibizumab Injection (Lucentis)
Ranitidine Hydrochloride Injection (Zantac Injection)
Raptiva
Reclast (Zoledronic Acid Injection)
Recombivarix HB
Regadenoson Injection (Lexiscan)
Reglan Injection (Metoclopramide Injection)
Remicade
Renagel
Renvela (Sevelamer Carbonate)

Repronex (Menotropins for Injection)
Retrovir IV (Zidovudine Injection)
rhApo2L/TRAIL
Ringer's and 5% Dextrose Injection (Ringers in Dextrose)
Ringer's Injection (Ringers Injection)
Rituxan
Rituximab
Rocephin (ceftriaxone)
Rocuronium Bromide Injection (Zemuron)
Roferon-A (interferon alfa-2a)
Romazicon (flumazenil)
Romidepsin for Injection (Istodax)
Saizen (Somatropin Injection)
Sandostatin LAR (Octreotide Acetate Injection)
Sclerostin Ab
Sensipar (cinacalcet)
Sensorcaine (Bupivacaine HCl Injections)
Septocaine (Articane HCl and Epinephrine Injection)
Serostim LQ (Somatropin (rDNA origin) Injection)
Simponi Injection (Golimumab Injection)
Sodium Acetate (Sodium Acetate Injection)
Sodium Bicarbonate (Sodium Bicarbonate 5% Injection)
Sodium Lactate (Sodium Lactate Injection in AVIVA)
Sodium Phenylacetate and Sodium Benzoate Injection (Ammonul)
Somatropin (rDNA origin) for Inj (Nutropin)
Sporanox Injection (Itraconazole Injection)
Stelara Injection (Ustekinumab)
Stemgen
Sufenta (Sufentanil Citrate Injection)
Sufentanil Citrate Injection (Sufenta)
Sumavel
Sumatriptan Injection (Alsuma)
Symlin
Symlin Pen

Systemic Hedgehog Antagonist
Synvisc-One (Hylan G-F 20 Single Intra-articular Injection)
Tarceva
Taxotere (Docetaxel for Injection)
Technetium Tc 99m
Telavancin for Injection (Vibativ)
Temsirolimus Injection (Torisel)
Tenormin I.V. Injection (Atenolol Inj)
Teriparatide (rDNA origin) Injection (Forteo)
Testosterone Cypionate
Testosterone Enanthate
Testosterone Propionate
Tev-Tropin (Somatropin, rDNA Origin, for Injection)
tgAAC94
Thallos Chloride
Theophylline
Thiotepa (Thiotepa Injection)
Thymoglobulin (Anti-Thymocyte Globulin (Rabbit))
Thyrogen (Thyrotropin Alfa for Injection)
Ticarcillin Disodium and Clavulanate Potassium Galaxy (Timentin Injection)
Tigan Injection (Trimethobenzamide Hydrochloride Injectable)
Timentin Injection (Ticarcillin Disodium and Clavulanate Potassium Galaxy)
TNKase
Tobramycin Injection (Tobramycin Injection)
Tocilizumab Injection (Actemra)
Torisel (Temsirolimus Injection)
Totect (Dexrazoxane for Injection, Intravenous Infusion Only)
Trastuzumab-DM1
Travasol (Amino Acids (Injection))
Treanda (Bendamustine Hydrochloride Injection)
Trelstar (Triptorelin Pamoate for Injectable Suspension)
Triamcinolone Acetonide
Triamcinolone Diacetate
Triamcinolone Hexacetonide Injectable Suspension (Aristospan Injection 20 mg)

Triesence (Triamcinolone Acetonide Injectable Suspension)
Trimethobenzamide Hydrochloride Injectable (Tigan Injection)
Trimetrexate Glucuronate Inj (Neutrexin)
Triptorelin Pamoate for Injectable Suspension (Trelstar)
Twinject
Trivaris (Triamcinolone Acetonide Injectable Suspension)
Trisenox (Arsenic Trioxide Injection)
Twinrix
Typhoid Vi
Ultravist (Iopromide Injection)
Urofollitropin for Injection (Metrodin)
Urokinase Injection (Kinlytic)
Ustekinumab (Stelara Injection)
Ultralente (U)
Valium (diazepam)
Valproate Sodium Injection (Depacon)
Valtropin (Somatropin Injection)
Vancomycin Hydrochloride (Vancomycin Hydrochloride Injection)
Vancomycin Hydrochloride Injection (Vancomycin Hydrochloride)
Vaprisol (Conivaptan Hcl Injection)
VAQTA
Vasovist (Gadofosveset Trisodium Injection for Intravenous Use)
Vectibix (Panitumumab Injection for Intravenous Use)
Venofer (Iron Sucrose Injection)
Verteporfin Inj (Visudyne)
Vibativ (Telavancin for Injection)
Victoza (Liraglutide [rDNA] Injection)
Vimpat (Iacosamide Tablet and Injection)
Vinblastine Sulfate (Vinblastine Sulfate Injection)
Vincasar PFS (Vincristine Sulfate Injection)
Victoza
Vincristine Sulfate (Vincristine Sulfate Injection)
Visudyne (Verteporfin Inj)
Vitamin B-12

Vivitrol (Naltrexone XR Inj)
Voluven (Hydroxyethyl Starch in Sodium Chloride Injection)
Xeloda
Xenical (orlistat)
Xeomin (Incobotulinumtoxin A for Injection)
Xolair
Zantac Injection (Ranitidine Hydrochloride Injection)
Zemplar Injection (Paricalcitol Injection Fliptop Vial)
Zemuron (Rocuronium Bromide Injection)
Zenapax (daclizumab)
Zevalin
Zidovudine Injection (Retrovir IV)
Zithromax Injection (Azithromycin)
Zn-DTPA (Pentetate Zinc Trisodium Injection)
Zofran Injection (Ondansetron Hydrochloride Injection)
Zingo
Zoledronic Acid for Inj (Zometa)
Zoledronic Acid Injection (Reclast)
Zometa (Zoledronic Acid for Inj)
Zosyn (Piperacillin and Tazobactam Injection)
Zyprexa Relprevv (Olanzapine Extended Release Injectable Suspension)

2.2 Liquid Drugs (Non-Injectable)

Abilify
AccuNeb (Albuterol Sulfate Inhalation Solution)
Actidose Aqua (Activated Charcoal Suspension)
Activated Charcoal Suspension (Actidose Aqua)
Advair
Agenerase Oral Solution (Amprenavir Oral Solution)
Akten (Lidocaine Hydrochloride Ophthalmic Gel)
Alamast (Pemirolast Potassium Ophthalmic Solution)
Albumin (Human) 5% Solution (Buminate 5%)
Albuterol Sulfate Inhalation Solution

Alinia
Alocril
Alphagan
Alrex
Alvesco
Amprenavir Oral Solution
Analpram-HC
Arformoterol Tartrate Inhalation Solution (Brovana)
Aristospan Injection 20 mg (Triamcinolone Hexacetonide Injectable Suspension)
Asacol
Asmanex
Astepro
Astepro (Azelastine Hydrochloride Nasal Spray)
Atrovent Nasal Spray (Ipratropium Bromide Nasal Spray)
Atrovent Nasal Spray .06
Augmentin ES-600
Azasite (Azithromycin Ophthalmic Solution)
Azelaic Acid (Finacea Gel)
Azelastine Hydrochloride Nasal Spray (Astepro)
Azelex (Azelaic Acid Cream)
Azopt (Brinzolamide Ophthalmic Suspension)
Bacteriostatic Saline
Balanced Salt
Bepotastine
Bactroban Nasal
Bactroban
Beclovent
Benzac W
Betimol
Betoptic S
Bepreve
Bimatoprost Ophthalmic Solution
Bleph 10 (Sulfacetamide Sodium Ophthalmic Solution 10%)
Brinzolamide Ophthalmic Suspension (Azopt)

Bromfenac Ophthalmic Solution (Xibrom)
Bromhist
Brovana (Arformoterol Tartrate Inhalation Solution)
Budesonide Inhalation Suspension (Pulmicort Respules)
Cambia (Diclofenac Potassium for Oral Solution)
Capex
Carac
Carboxine-PSE
Carnitor
Cayston (Aztreonam for Inhalation Solution)
Cellcept
Centany
Cerumenex
Ciloxan Ophthalmic Solution (Ciprofloxacin HCL Ophthalmic Solution)
Ciprodex
Ciprofloxacin HCL Ophthalmic Solution (Ciloxan Ophthalmic Solution)
Clemastine Fumarate Syrup (Clemastine Fumarate Syrup)
CoLyte (PEG Electrolytes Solution)
Combiven
Comtan
Condylox
Cordran
Cortisporin Ophthalmic Suspension
Cortisporin Otic Suspension
Cromolyn Sodium Inhalation Solution (Intal Nebulizer Solution)
Cromolyn Sodium Ophthalmic Solution (Opticrom)
Crystalline Amino Acid Solution with Electrolytes (Aminosyn Electrolytes)
Cutivate
Cuvposa (Glycopyrrolate Oral Solution)
Cyanocobalamin (CaloMist Nasal Spray)
Cyclosporine Oral Solution (Gengraf Oral Solution)
Cyclogyl
Cysview (Hexaminolevulinate Hydrochloride Intravesical Solution)
DermOtic Oil (Fluocinolone Acetonide Oil Ear Drops)

Desmopressin Acetate Nasal Spray
DDAVP
Derma-Smoothe/FS
Dexamethasone Intensol
Dianeal Low Calcium
Dianeal PD
Diclofenac Potassium for Oral Solution (Cambia)
Didanosine Pediatric Powder for Oral Solution (Videx)
Differin
Dilantin 125 (Phenytoin Oral Suspension)
Ditropan
Dorzolamide Hydrochloride Ophthalmic Solution (Trusopt)
Dorzolamide Hydrochloride-Timolol Maleate Ophthalmic Solution (Cosopt)
Dovonex Scalp (Calcipotriene Solution)
Doxycycline Calcium Oral Suspension (Vibramycin Oral)
Efudex
Elaprase (Idursulfase Solution)
Elestat (Epinastine HCl Ophthalmic Solution)
Elocon
Epinastine HCl Ophthalmic Solution (Elestat)
Epivir HBV
Epogen (Epoetin alfa)
Erythromycin Topical Solution 1.5% (Staticin)
Ethiodol (Ethiodized Oil)
Ethosuximide Oral Solution (Zarontin Oral Solution)
Eurax
Extraneal (Icodextrin Peritoneal Dialysis Solution)
Felbatol
Feridex I.V. (Ferumoxides Injectable Solution)
Flovent
Floxin Otic (Ofloxacin Otic Solution)
Flo-Pred (Prednisolone Acetate Oral Suspension)
Fluoroplex
Flunisolide Nasal Solution (Flunisolide Nasal Spray .025%)

Fluorometholone Ophthalmic Suspension (FML)
Flurbiprofen Sodium Ophthalmic Solution (Ocufen)
FML
Foradil
Formoterol Fumarate Inhalation Solution (Perforomist)
Fosamax
Furadantin (Nitrofurantoin Oral Suspension)
Furoxone
Gammagard Liquid (Immune Globulin Intravenous (Human) 10%)
Gantrisin (Acetyl Sulfisoxazole Pediatric Suspension)
Gatifloxacin Ophthalmic Solution (Zymar)
Gengraf Oral Solution (Cyclosporine Oral Solution)
Glycopyrrolate Oral Solution (Cuvposa)
Halcinonide Topical Solution (Hallog Solution)
Hallog Solution (Halcinonide Topical Solution)
HEP-LOCK U/P (Preservative-Free Heparin Lock Flush Solution)
Heparin Lock Flush Solution (Hepflush 10)
Hexaminolevulinate Hydrochloride Intravesical Solution (Cysview)
Hydrocodone Bitartrate and Acetaminophen Oral Solution (Lortab Elixir)
Hydroquinone 3% Topical Solution (Melquin-3 Topical Solution)
IAP Antagonist
Isopto
Ipratropium Bromide Nasal Spray (Atrovent Nasal Spray)
Itraconazole Oral Solution (Sporanox Oral Solution)
Ketorolac Tromethamine Ophthalmic Solution (Acular LS)
Kaletra
Lanoxin
Lexiva
Leuprolide Acetate for Depot Suspension (Lupron Depot 11.25 mg)
Levobetaxolol Hydrochloride Ophthalmic Suspension (Betaxon)
Levocarnitine Tablets, Oral Solution, Sugar-Free (Carnitor)
Levofloxacin Ophthalmic Solution 0.5% (Quixin)
Lidocaine HCl Sterile Solution (Xylocaine MPF Sterile Solution)
Lok Pak (Heparin Lock Flush Solution)

Lorazepam Intensol
Lortab Elixir (Hydrocodone Bitartrate and Acetaminophen Oral Solution)
Lotemax (Loteprednol Etabonate Ophthalmic Suspension)
Loteprednol Etabonate Ophthalmic Suspension (Alrex)
Low Calcium Peritoneal Dialysis Solutions (Dianeal Low Calcium)
Lumigan (Bimatoprost Ophthalmic Solution 0.03% for Glaucoma)
Lupron Depot 11.25 mg (Leuprolide Acetate for Depot Suspension)
Megestrol Acetate Oral Suspension (Megestrol Acetate Oral Suspension)
MEK Inhibitor
Mepron
Mesnex
Mestinon
Mesalamine Rectal Suspension Enema (Rowasa)
Melquin-3 Topical Solution (Hydroquinone 3% Topical Solution)
MetMab
Methyldopate HCl (Methyldopate Hydrochloride Injection, Solution)
Methylin Oral Solution (Methylphenidate HCl Oral Solution 5 mg/5 mL and 10 mg/5 mL)
Methylprednisolone Acetate Injectable Suspension (Depo Medrol)
Methylphenidate HCl Oral Solution 5 mg/5 mL and 10 mg/5 mL (Methylin Oral Solution)
Methylprednisolone sodium succinate (Solu Medrol)
Metipranolol Ophthalmic Solution (Optipranolol)
Migranal
Miochol-E (Acetylcholine Chloride Intraocular Solution)
Micro-K for Liquid Suspension (Potassium Chloride Extended Release Formulation for Liquid Suspension)
Minocin (Minocycline Hydrochloride Oral Suspension)
Nasacort
Neomycin and Polymyxin B Sulfates and Hydrocortisone
Nepafenac Ophthalmic Suspension (Nevanac)
Nevanac (Nepafenac Ophthalmic Suspension)
Nitrofurantoin Oral Suspension (Furadantin)
Noxafil (Posaconazole Oral Suspension)
Nystatin (oral) (Nystatin Oral Suspension)
Nystatin Oral Suspension (Nystatin (oral))
Ocufen (Flurbiprofen Sodium Ophthalmic Solution)

Ofloxacin Ophthalmic Solution (Ofloxacin Ophthalmic Solution)
Ofloxacin Otic Solution (Floxin Otic)
Olopatadine Hydrochloride Ophthalmic Solution (Pataday)
Opticrom (Cromolyn Sodium Ophthalmic Solution)
Optipranolol (Metipranolol Ophthalmic Solution)
Patanol
Pediapred
PerioGard
Phenytoin Oral Suspension (Dilantin 125)
Phisohex
Posaconazole Oral Suspension (Noxafil)
Potassium Chloride Extended Release Formulation for Liquid Suspension (Micro-K for Liquid Suspension)
Pataday (Olopatadine Hydrochloride Ophthalmic Solution)
Patanase Nasal Spray (Olopatadine Hydrochloride Nasal Spray)
PEG Electrolytes Solution (CoLyte)
Pemirolast Potassium Ophthalmic Solution (Alamast)
Penlac (Ciclopirox Topical Solution)
PENNSAID (Diclofenac Sodium Topical Solution)
Perforomist (Formoterol Fumarate Inhalation Solution)
Peritoneal Dialysis Solution
Phenylephrine Hydrochloride Ophthalmic Solution (Neo-Syneprine)
Phospholine Iodide (Echothiophate Iodide for Ophthalmic Solution)
Podofilox (Podofilox Topical Solution)
Pred Forte (Prednisolone Acetate Ophthalmic Suspension)
Pralatrexate Solution for Intravenous Injection (Folotyn)
Pred Mild
Prednisone Intensol
Prednisolone Acetate Ophthalmic Suspension (Pred Forte)
Prevacid
PrismaSol Solution (Sterile Hemofiltration Hemodiafiltration Solution)
ProAir
Proglycem
ProHance (Gadoteridol Injection Solution)
Proparacaine Hydrochloride Ophthalmic Solution (Alcaine)

Propine
Pulmicort
Pulmozyme
Quixin (Levofloxacin Ophthalmic Solution 0.5%)
QVAR
Rapamune
Rebetol
Relacon-HC
Rotarix (Rotavirus Vaccine, Live, Oral Suspension)
Rotavirus Vaccine, Live, Oral Suspension (Rotarix)
Rowasa (Mesalamine Rectal Suspension Enema)
Sabril (Vigabatrin Oral Solution)
Sacrosidase Oral Solution (Sucraid)
Sandimmune
Sepra
Serevent Diskus
Solu Cortef (Hydrocortisone Sodium Succinate)
Solu Medrol (Methylprednisolone sodium succinate)
Spiriva
Sporanox Oral Solution (Itraconazole Oral Solution)
Staticin (Erythromycin Topical Solution 1.5%)
Stalevo
Starlix
Sterile Hemofiltration Hemodiafiltration Solution (PrismaSol Solution)
Stimate
Sucralfate (Carafate Suspension)
Sulfacetamide Sodium Ophthalmic Solution 10% (Bleph 10)
Synarel Nasal Solution (Nafarelin Acetate Nasal Solution for Endometriosis)
Taclonex Scalp (Calcipotriene and Betamethasone Dipropionate Topical Suspension)
Tamiflu
Tobi
TobraDex
Tobradex ST (Tobramycin / Dexamethasone Ophthalmic Suspension 0.3%/0.05%)
Tobramycin / Dexamethasone Ophthalmic Suspension 0.3%/0.05% (Tobradex ST)

Timolol
Timoptic
Travatan Z
Treprostinil Inhalation Solution (Tyvaso)
Trusopt (Dorzolamide Hydrochloride Ophthalmic Solution)
Tyvaso (Treprostinil Inhalation Solution)
Ventolin
Vfend
Vibramycin Oral (Doxycycline Calcium Oral Suspension)
Videx (Didanosine Pediatric Powder for Oral Solution)
Vigabatrin Oral Solution (Sabril)
Viokase
Viracept
Viramune
Vitamin K1 (Aqueous Colloidal Solution of Vitamin K1)
Voltaren Ophthalmic (Diclofenac Sodium Ophthalmic Solution)
Zarontin Oral Solution (Ethosuximide Oral Solution)
Ziagen
Zyvox
Zymar (Gatifloxacin Ophthalmic Solution)
Zymaxid (Gatifloxacin Ophthalmic Solution)

2.3 Drug Classes

5-alpha-reductase inhibitors
5-aminosalicylates
5HT3 receptor antagonists
adamantane antivirals
adrenal cortical steroids
adrenal corticosteroid inhibitors
adrenergic bronchodilators
agents for hypertensive emergencies
agents for pulmonary hypertension
aldosterone receptor antagonists

alkylating agents
alpha-adrenoreceptor antagonists
alpha-glucosidase inhibitors
alternative medicines
amebicides
aminoglycosides
aminopenicillins
aminosalicylates
amylin analogs
Analgesic Combinations
Analgesics
androgens and anabolic steroids
angiotensin converting enzyme inhibitors
angiotensin II inhibitors
anorectal preparations
anorexiant
antacids
anthelmintics
anti-angiogenic ophthalmic agents
anti-CTLA-4 monoclonal antibodies
anti-infectives
antiadrenergic agents, centrally acting
antiadrenergic agents, peripherally acting
antiandrogens
antianginal agents
antiarrhythmic agents
antiasthmatic combinations
antibiotics/antineoplastics
anticholinergic antiemetics
anticholinergic antiparkinson agents
anticholinergic bronchodilators
anticholinergic chronotropic agents
anticholinergics/antispasmodics
anticoagulants

anticonvulsants
antidepressants
antidiabetic agents
antidiabetic combinations
antidiarrheals
antidiuretic hormones
antidotes
antiemetic/antivertigo agents
antifungals
antigonadotropic agents
antigout agents
antihistamines
antihyperlipidemic agents
antihyperlipidemic combinations
antihypertensive combinations
antihyperuricemic agents
antimalarial agents
antimalarial combinations
antimalarial quinolines
antimetabolites
antimigraine agents
antineoplastic detoxifying agents
antineoplastic interferons
antineoplastic monoclonal antibodies
antineoplastics
antiparkinson agents
antiplatelet agents
antipseudomonal penicillins
antipsoriatics
antipsychotics
antirheumatics
antiseptic and germicides
antithyroid agents
antitoxins and antivenins

antituberculosis agents
antituberculosis combinations
antitussives
antiviral agents
antiviral combinations
antiviral interferons
anxiolytics, sedatives, and hypnotics
aromatase inhibitors
atypical antipsychotics
azole antifungals
bacterial vaccines
barbiturate anticonvulsants
barbiturates
BCR-ABL tyrosine kinase inhibitors
benzodiazepine anticonvulsants
benzodiazepines
beta-adrenergic blocking agents
beta-lactamase inhibitors
bile acid sequestrants
biologicals
bisphosphonates
bone resorption inhibitors
bronchodilator combinations
bronchodilators
calcitonin
calcium channel blocking agents
carbamate anticonvulsants
carbapenems
carbonic anhydrase inhibitor anticonvulsants
carbonic anhydrase inhibitors
cardiac stressing agents
cardioselective beta blockers
cardiovascular agents
catecholamines

CD20 monoclonal antibodies
CD33 monoclonal antibodies
CD52 monoclonal antibodies
central nervous system agents
cephalosporins
cerumenolytics
chelating agents
chemokine receptor antagonist
chloride channel activators
cholesterol absorption inhibitors
cholinergic agonists
cholinergic muscle stimulants
cholinesterase inhibitors
CNS stimulants
coagulation modifiers
colony stimulating factors
contraceptives
corticotropin
coumarins and indandiones
cox-2 inhibitors
decongestants
dermatological agents
diagnostic radiopharmaceuticals
dibenzazepine anticonvulsants
digestive enzymes
dipeptidyl peptidase 4 inhibitors
diuretics
dopaminergic antiparkinsonism agents
drugs used in alcohol dependence
echinocandins
EGFR inhibitors
estrogen receptor antagonists
estrogens
expectorants

factor Xa inhibitors
fatty acid derivative anticonvulsants
fibrin acid derivatives
first generation cephalosporins
fourth generation cephalosporins
functional bowel disorder agents
gallstone solubilizing agents
gamma-aminobutyric acid analogs
gamma-aminobutyric acid reuptake inhibitors
gamma-aminobutyric acid transaminase inhibitors
gastrointestinal agents
general anesthetics
genitourinary tract agents
GI stimulants
glucocorticoids
glucose elevating agents
glycopeptide antibiotics
glycoprotein platelet inhibitors
glycylcyclines
gonadotropin releasing hormones
gonadotropin-releasing hormone antagonists
gonadotropins
group I antiarrhythmics
group II antiarrhythmics
group III antiarrhythmics
group IV antiarrhythmics
group V antiarrhythmics
growth hormone receptor blockers
growth hormones
H. pylori eradication agents
H2 antagonists
hematopoietic stem cell mobilizer
heparin antagonists
heparins

HER2 inhibitors
herbal products
histone deacetylase inhibitors
hormone replacement therapy
hormones
hormones/antineoplastics
hydantoin anticonvulsants
illicit (street) drugs
immune globulins
immunologic agents
immunosuppressive agents
impotence agents
in vivo diagnostic biologicals
incretin mimetics
inhaled anti-infectives
inhaled corticosteroids
inotropic agents
insulin
insulin-like growth factor
integrase strand transfer inhibitor
interferons
intravenous nutritional products
iodinated contrast media
ionic iodinated contrast media
iron products
ketolides
laxatives
leprostatics
leukotriene modifiers
lincomycin derivatives
lipoglycopeptides
local injectable anesthetics
loop diuretics
lung surfactants

lymphatic staining agents
lysosomal enzymes
macrolide derivatives
macrolides
magnetic resonance imaging contrast media
mast cell stabilizers
medical gas
meglitinides
metabolic agents
methylxanthines
mineralocorticoids
minerals and electrolytes
miscellaneous agents
miscellaneous analgesics
miscellaneous antibiotics
miscellaneous anticonvulsants
miscellaneous antidepressants
miscellaneous antidiabetic agents
miscellaneous antiemetics
miscellaneous antifungals
miscellaneous antihyperlipidemic agents
miscellaneous antimalarials
miscellaneous antineoplastics
miscellaneous antiparkinson agents
miscellaneous antipsychotic agents
miscellaneous antituberculosis agents
miscellaneous antivirals
miscellaneous anxiolytics, sedatives and hypnotics
miscellaneous biologicals
miscellaneous bone resorption inhibitors
miscellaneous cardiovascular agents
miscellaneous central nervous system agents
miscellaneous coagulation modifiers
miscellaneous diuretics

miscellaneous genitourinary tract agents
miscellaneous GI agents
miscellaneous hormones
miscellaneous metabolic agents
miscellaneous ophthalmic agents
miscellaneous otic agents
miscellaneous respiratory agents
miscellaneous sex hormones
miscellaneous topical agents
miscellaneous uncategorized agents
miscellaneous vaginal agents
mitotic inhibitors
monoamine oxidase inhibitors
monoclonal antibodies
mouth and throat products
mTOR inhibitors
mTOR kinase inhibitors
mucolytics
multikinase inhibitors
muscle relaxants
mydriatics
narcotic analgesic combinations
narcotic analgesics
nasal anti-infectives
nasal antihistamines and decongestants
nasal lubricants and irrigations
nasal preparations
nasal steroids
natural penicillins
neuraminidase inhibitors
neuromuscular blocking agents
next generation cephalosporins
nicotinic acid derivatives
nitrates

NNRTIs

non-cardioselective beta blockers
non-iodinated contrast media
non-ionic iodinated contrast media
non-sulfonylureas
nonsteroidal anti-inflammatory agents
norepinephrine reuptake inhibitors
norepinephrine-dopamine reuptake inhibitors
nucleoside reverse transcriptase inhibitors (NRTIs)
nutraceutical products
nutritional products
ophthalmic anesthetics
ophthalmic anti-infectives
ophthalmic anti-inflammatory agents
ophthalmic antihistamines and decongestants
ophthalmic diagnostic agents
ophthalmic glaucoma agents
ophthalmic lubricants and irrigations
ophthalmic preparations
ophthalmic steroids
ophthalmic steroids with anti-infectives
ophthalmic surgical agents
oral nutritional supplements
otic anesthetics
otic anti-infectives
otic preparations
otic steroids
otic steroids with anti-infectives
oxazolidinone anticonvulsants
parathyroid hormone and analogs
penicillinase resistant penicillins
penicillins
peripheral opioid receptor antagonists
peripheral vasodilators

peripherally acting antiobesity agents
phenothiazine antiemetics
phenothiazine antipsychotics
phenylpiperazine antidepressants
plasma expanders
platelet aggregation inhibitors
platelet-stimulating agents
polyenes
potassium-sparing diuretics
probiotics
progesterone receptor modulators
progestins
prolactin inhibitors
prostaglandin D2 antagonists
protease inhibitors
proton pump inhibitors
psoralens
psychotherapeutic agents
psychotherapeutic combinations
purine nucleosides
pyrrolidine anticonvulsants
quinolones
radiocontrast agents
radiologic adjuncts
radiologic agents
radiologic conjugating agents
radiopharmaceuticals
RANK ligand inhibitors
recombinant human erythropoietins
renin inhibitors
respiratory agents
respiratory inhalant products
rifamycin derivatives
salicylates

sclerosing agents
second generation cephalosporins
selective estrogen receptor modulators
selective serotonin reuptake inhibitors
serotonin-norepinephrine reuptake inhibitors
serotonergic neuroenteric modulators
sex hormone combinations
sex hormones
skeletal muscle relaxant combinations
skeletal muscle relaxants
smoking cessation agents
somatostatin and somatostatin analogs
spermicides
statins
sterile irrigating solutions
streptomyces derivatives
succinimide anticonvulsants
sulfonamides
sulfonylureas
synthetic ovulation stimulants
tetracyclic antidepressants
tetracyclines
therapeutic radiopharmaceuticals
thiazide diuretics
thiazolidinediones
thioxanthenes
third generation cephalosporins
thrombin inhibitors
thrombolytics
thyroid drugs
tocolytic agents
topical acne agents
topical agents
topical anesthetics

topical anti-infectives
topical antibiotics
topical antifungals
topical antihistamines
topical antipsoriatics
topical antivirals
topical astringents
topical debriding agents
topical depigmenting agents
topical emollients
topical keratolytics
topical steroids
topical steroids with anti-infectives
toxoids
triazine anticonvulsants
tricyclic antidepressants
trifunctional monoclonal antibodies
tumor necrosis factor (TNF) inhibitors
tyrosine kinase inhibitors
ultrasound contrast media
upper respiratory combinations
urea anticonvulsants
urinary anti-infectives
urinary antispasmodics
urinary pH modifiers
uterotonic agents
vaccine
vaccine combinations
vaginal anti-infectives
vaginal preparations
vasodilators
vasopressin antagonists
vasopressors
VEGF/VEGFR inhibitors

viral vaccines

viscosupplementation agents

vitamin and mineral combinations

vitamins

Table 3. Potential Diagnostic Tests for Use with Plasma-Coated Vessels for Sample Retention.

The list provided in this table includes examples of diagnostic tests for which the use of plasma-coated vessels can be used for sample retention. It should be understood that this list is non-exhaustive and intended as exemplary only. The use of plasma-coated vessels is contemplated for retention of biological samples of all types and for all types of diagnostic tests, and implementation of the plasma coating technology described above in vessels for biological sample retention for tests not appearing in the list below would be a matter of routine experimentation.

17-Hydroxyprogesterone
ACE (Angiotensin I converting enzyme)
Acetaminophen
Acid phosphatase
ACTH
Activated clotting time
Activated protein C resistance
Adrenocorticotrophic hormone (ACTH)
Alanine aminotransferase (ALT)
Albumin
Aldolase
Aldosterone
Alkaline phosphatase
Alkaline phosphatase (ALP)
Alpha1-antitrypsin
Alpha-fetoprotein
Alpha-fetoprotien
Ammonia levels
Amylase
ANA (antinuclear antibodies)
ANA (antinuclear antibodies)
Angiotensin-converting enzyme (ACE)
Anion gap
Anticardiolipin antibody
Anticardiolipin antibodies (ACA)
Anti-centromere antibody
Antidiuretic hormone

Anti-DNA
Anti-Dnase-B
Anti-Gliadin antibody
Anti-glomerular basement membrane antibody
Anti-HBc (Hepatitis B core antibodies)
Anti-HBs (Hepatitis B surface antibody)
Antiphospholipid antibody
Anti-RNA polymerase
Anti-Smith (Sm) antibodies
Anti-Smooth Muscle antibody
Antistreptolysin O (ASO)
Antithrombin III
Anti-Xa activity
Anti-Xa assay
Apolipoproteins
Arsenic
Aspartate aminotransferase (AST)
B12
Basophil
Beta-2-Microglobulin
Beta-hydroxybutyrate
B-HCG
Bilirubin
Bilirubin, direct
Bilirubin, indirect
Bilirubin, total
Bleeding time
Blood gases (arterial)
Blood urea nitrogen (BUN)
BUN
BUN (blood urea nitrogen)
CA 125
CA 15-3
CA 19-9

Calcitonin
Calcium
Calcium (ionized)
Carbon monoxide (CO)
Carcinoembryonic antigen (CEA)
CBC
CEA
CEA (carcinoembryonic antigen)
Ceruloplasmin
CH50Chloride
Cholesterol
Cholesterol, HDL
Clot lysis time
Clot retraction time
CMP
CO₂
Cold agglutinins
Complement C3
Copper
Corticotrophin releasing hormone (CRH) stimulation test
Cortisol
Cortrosyn stimulation test
C-peptide
CPK (Total)
CPK-MB
C-reactive protein
Creatinine
Creatinine kinase (CK)
Cryoglobulins
DAT (Direct antiglobulin test)
D-Dimer
Dexamethasone suppression test
DHEA-S
Dilute Russell viper venom

Elliptocytes
Eosinophil
Erythrocyte sedimentation rate (ESR)
Estradiol
Estriol
Ethanol
Ethylene glycol
Euglobulin lysis
Factor V Leiden
Factor VIII inhibitor
Factor VIII level
Ferritin
Fibrin split products
Fibrinogen
Folate
Folate (serum)
Fractional excretion of sodium (FENA)
FSH (follicle stimulating factor)
FTA-ABS
Gamma glutamyl transferase (GGT)
Gastrin
GGTP (Gamma glutamyl transferase)
Glucose
Growth hormone
Haptoglobin
HBeAg (Hepatitis Be antigen)
HBs-Ag (Hepatitis B surface antigen)
Helicobacter pylori
Hematocrit
Hematocrit (HCT)
Hemoglobin
Hemoglobin A1C
Hemoglobin electrophoresis
Hepatitis A antibodies

Hepatitis C antibodies
IAT (Indirect antiglobulin test)
Immunofixation (IFE)
Iron
Lactate dehydrogenase (LDH)
Lactic acid (lactate)
LDH
LH (Leutinizing hormone)
Lipase
Lupus anticoagulant
Lymphocyte
Magnesium
MCH (mean corpuscular hemoglobin)
MCHC (mean corpuscular hemoglobin concentration)
MCV (mean corpuscular volume)
Methylmalonate
Monocyte
MPV (mean platelet volume)
Myoglobin
Neutrophil
Parathyroid hormone (PTH)
Phosphorus
Platelets (plt)
Potassium
Prealbumin
Prolactin
Prostate specific antigen (PSA)
Protein C
Protein S
PSA (prostate specific antigen)
PT (Prothrombin time)
PTT (Partial thromboplastin time)
RDW (red cell distribution width)
Renin

Rennin
Reticulocyte count
reticulocytes
Rheumatoid factor (RF)
Sed Rate
Serum glutamic-pyruvic transaminase (SGPT)
Serum protein electrophoresis (SPEP)
Sodium
T3-resin uptake (T3RU)
T4, Free
Thrombin time
Thyroid stimulating hormone (TSH)
Thyroxine (T4)
Total iron binding capacity (TIBC)
Total protein
Transferrin
Transferrin saturation
Triglyceride (TG)
Troponin
Uric acid
Vitamin B12
White blood cells (WBC)
Widal test

Table 4. Pre-fill Syringe Devices: Incumbent Product Issues, Plasma Coating Technology Improvements and Impact.

Incumbent Product (plastic tube device) Issues	Plasma Technology Improvement	Impact
Glass syringe barrels are expensive, heavy, and have high potential for breakage resulting in loss of expensive prescription medicines	A plasma-coated plastic syringe barrel will be less expensive, lighter, and more resistant to breakage.	Less expensive, lighter, and more durable pre-filled packages will drive growth of the prefill syringe market
Glass syringe barrels leach metals into fluid contents	20-40 nanometer thick plasma SiO ₂ coated plastic syringe barrels are free of metal content present in traditional glasses	Synthetic and biological drugs and pharmaceuticals will have no metal interactions, extending the assay and shelf life of pre-filled syringe products
PET syringes permeate oxygen/ moisture affecting additive reagent assay levels	20-40 nanometer thick SiO ₂ -coated PET syringes reduce oxygen permeation rates 300+%	Additive reagent assay levels will be more stable, providing increased clinical analysis reliability
PET syringes contains trace metal and organic compositions which can leach into syringe contents	20-40 nanometer thick SiO ₂ -coated PET tubes reduce (inorganic and organic) leaching rates	Syringe formulations will be more stable, offering improved dose administration accuracy and longer shelf life.
Elastomeric tips (sealing the syringe plunger to the barrel) contain trace metal and organic compositions which can leach	Plasma-coated elastomeric closures reduce (inorganic and organic) leaching rates	Syringe formulations will be more stable, offering improved dose administration accuracy and longer shelf life.
Silicone fluids for plunger/barrel lubricity demonstrate high leachable levels into pharmaceutical formulations, which are delivered into the blood stream.	Polymeric plasma-coatings on plastic syringes can provide lubricity with reduced leaching	Syringe formulations will be more stable, offering improved dose administration accuracy and longer shelf life.
Cyclic olefin copolymer (COC) syringe barrels permeate oxygen affecting additive pharmaceutical assay levels	20-40 nanometer thick SiO ₂ -coated plastic syringe barrels reduce oxygen permeation rates 300+%	Syringe formulations will be more stable, offering improved dose administration accuracy and longer shelf life.

Table 5. In-Line Coating Verification Methods.

	Method	Detection Principle	Detection Mode	Speed	Non-Destructive	Practical	Sensitivity
	Mass Transfer						
	Helium Permeation	differential permeation rates (uncoated/coated)	helium mass spectrometer	-	+	-	+++
A1	Wall (Air) Diffusion	differential wall diffusion rates (uncoated/coated)	pressure transducer	+	+	++	+
A2	Wall (Oxygen) Diffusion	differential wall diffusion rates (uncoated/coated)	fluorescence spectrometer	+	+	++	++
A3	Wall (Microflow) Diffusion	differential wall diffusion rates (uncoated/coated)	capacitance bridge	+	+	++	+++
A4	Wall (Helium) Diffusion	differential wall diffusion rates (uncoated/coated)	helium mass spectrometer	+	+	-	+++
	Photon Transfer						
	Reflectance	reflectance (uncoated/coated)	500-800 nm spectrometer	+	+	-	++
A5	Transmission	absorption (uncoated/coated)	500-800 nm spectrometer	+	+	+	+
A6	Transmission	absorption (SiOx/CyHz coated)	1-10 micron spectrometer	+	+	+	
	Electron Transfer						
	Volume Resistivity	resistance (uncoated/ coated)	ohm meter	+	-	-	-
A7	Breakdown Voltage	leakage current (uncoated/coated)	ammeter	+	+	-	-
	Sound Wave Transfer						
	Ultrasonic	frequency shift (uncoated/coated)	ultrasonic detector	+	+	-	-

(A) Mass Transfer Rate Methods

Initial efforts were directed toward measurement of gas permeation rates through the plastic article. Knowing that standard (MOCON) oxygen transmission rate (OTR) measurements required 3 and 5+ days for equilibration and gas permeation through a 1mm thick blood tube, high pressure (100 psi) helium transmission to facilitate faster permeation and offer a very sensitive (He has 5ppm natural abundance in air) measurement method for distinguishing pinhole defects was investigated. While fast helium permeation (less than 55 seconds) was realized, the plasma coating was not sufficiently dense to provide a higher resistance than an uncoated tube to helium permeation, thus both coated and uncoated plastic articles exhibited the same permeation rate.

Based on these findings, rather than looking for full permeation through the article, efforts were directed toward investigating inner wall gas depletion (surface diffusion/degassing) rates under a partial vacuum. The principle is to differentiate the rate of gas diffusion from the inner wall of the article, based on the presence or absence of a SiO₂ barrier coating.

(A1) Wall (air) Diffusion Rate (pressure change) – Use of pressure transducers offers fast (seconds), high precision determination of air diffusion rate differences between uncoated and coated plastic articles.

(A2) Wall (oxygen) Diffusion Rate (oxygen fluorescence) – Use of fiber optic-based fluorescence detectors (Ocean Optics) offer fast (0.5 seconds), high sensitivity (5x air) determination of oxygen diffusion rate differences between uncoated and coated plastic articles.

(A3) Wall (air) Diffusion Rate (change in gas flow via capacitance measurement) – Use of microflow controllers (Advanced Test Concepts) offer fast, high sensitivity (comparable to helium detection) with surface degassing. This technique may also be incorporated for leak detection for closure/tube vacuum integrity prior to labeling/packaging.

Methods A1-A3 should provide coating coverage determination precision within +/- 0.2 percent precision. These methods can be simultaneously operated with respective probe attachments to (the coater hardware) vacuum manifold, and do not require direct interaction with the plastic article/puck system. These wall diffusion rate methods are relative methods and will (a) require either measurement of diffusion rate both before (uncoated) and after (coated) or statistical uncoated tube calibration and (b) correlation to physical (MOCON OTR, Accelerated Aging Water Draw) or clinical data. Method A3 has demonstrated the capability to distinguish between coated and uncoated tubes. One recent finding is that the rate of wall diffusion is greatly affected by the equilibration condition of the PET tube. Therefore it may be critical to maintain a controlled environment for the PET tube prior to testing. Additionally the precision of the test can potentially be improved by increasing the ambient RH that the tubes are exposed to prior to coating and between coating and testing. This will accentuate the difference between a coated and uncoated tube and also increase the diffusion through any small areas of the tube that are either uncoated or the coating is damaged.

Increased sensitivity of the degassing measurement using Microflow can be realized by using a carbon dioxide flush and/or by spiking the test sample with carbon dioxide gas. This is particularly useful when testing COC substrates where the solubility for nitrogen, water and oxygen are low.

Photon Transfer Methods

Photon transfer methods can be broadly grouped into two categories; methods which interrogate a particular area (mm²) on the plastic article and methods which interrogate the overall article, the latter similar to the Mass Transfer methods previously discussed. [Separately, in contrast to glass articles, PET plastic articles have significant absorption bands in the UV (200-400 nm) wavelength range. Both the relative thicknesses of plastic substrate/coating and intrinsic UV absorption of PET plastics make UV wavelength measurement difficult. Visible and Infrared absorptions of SiO₂ and SiO_xCyHz coating compositions have been investigated.]

Use of reflectance, transmission/absorbance, and fluorescence measurement of coatings for specific area (mm²) detection has been a key method for flat thin films.

With tubes and syringe barrels, the nature of their curved surface and on-line multiple article/puck assemblies make specific area coating detection problematic due to difficulty in reproducible positioning [distance (x), location (y, z) angle (pitch/yaw)]. Also, area detection methods have difficulty to address article thickness transition areas, such as blood tube cylinder-to-bottom sphere interface and molding tip (at bottom of blood tube), and syringe barrel luer adaptor and capillary sections. On the other hand, use of total article detection methods, particularly transmission methods are showing good correlation to mass transfer methods.

(A4) Optical Transmission – Use of fiber optic-based transmission (from 640nmLED source), a integrating sphere light collector, and visible spectrometer detector (Ocean Optics) offers fast (100 millisecond) coating detection through reduced transmittance of coated tubes relative to uncoated tubes.

This method will be complementary to the mass transfer methods, but not likely have coating coverage determination precision of better than +/-1 percent. This method does require both LED light source and integrating sphere to be in plastic article/puck proximity, but the sphere can be easily lowered and raised onto the tube/puck assembly for measurement. It is envisioned this method would be a multiple station circular array detection approach similar to the coating array.

(A5) Infrared Transmission – Use of fiber optic Near Infrared Detectors will enable area detection of SiOxCyHz lubricity coating compositions on plastic syringe barrels.

Electron Transfer Methods

High resolution analytical techniques (Scanning Electron Microscopy, Scanning Transmission Electron Microscopy) provide highly desirable, nanometer coating thickness characterization, but these are essentially destructive and very costly techniques, not readily adaptable to a fast online process.