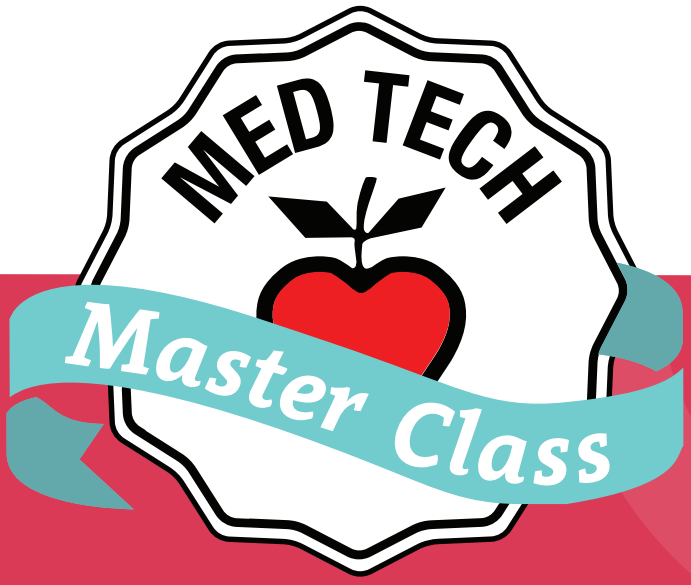


Everything You Need To Know About Medical-Grade Rubber Compounds

Apple Rubber

applerubber.com/askapple

MED TECH Master Class

The medical industry has utilized Rubber O-Rings and seals throughout history. These components can seal a variety of devices ranging from critical electronics to implanted devices and dust covers for surgical equipment. Making sure you have the right material during the design phase can assure quick regulatory approval or prevent duplicate testing caused by the use of an unapproved material.

To help you better understand, we broke down everything you need to know about medical rubber compounds.

Medical-grade rubber compounds endure quality standards.

The FDA does not approve the individual materials used in a medical device. FDA only approves a final device which incorporates many components and materials. It's important for medical device manufacturers to use risk assessments to figure out where issues with materials and components can affect end use of the product. Biocompatibility evaluations done on rubber materials can help give a better prediction for the risk assessment of the final product.

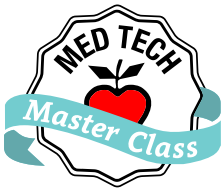
Raw material suppliers and rubber compounders test their compounds to show that under standard conditions the materials should not have the negative interactions that occur during biological evaluations. It's up to the device manufacturer to assure that additional exposures like sterilization or chemical contact will not affect the material and cause negative interactions.

Medical rubber, for the most part, consists of rubber compounds that pass a series of biocompatibility tests. Typically, the terms USP Class VI or ISO 10993 materials are used. Unlike other rubber standards, there's no one standard that engineers use for an approval.

Take an ASTM D2000 call out. A rubber compound has set physical parameters it needs to meet. Class VI and ISO 10993 are recommendations for testing based on the use of the final device. If the device has no blood path contact, then there is less testing. If the device will be implanted, then it will have significantly more recommended testing. There are many other test protocols, like USP<381>, USP<87> or USP <88>, but we will only focus on the above two.

They're biocompatible.

Biocompatibility for medical devices refers to the ability of the device to elicit the desired biological response without causing adverse effects in the body. Engineers determine the testing by the nature of the tissue contact and the duration of the tissue contact. Three categories of devices are surface contacting device, external communicating device and implant device. Duration is broken down to Limited (<= 24 hours), Prolonged (> 24 hours to 30 days) and Permanent (>30 Days).



Medical-grade rubber has a USP class designation.

USP testing is typically used for the assessment of pharmaceutical containers and materials which may come in contact with drugs during manufacturing. The below table[2] shows how the USP standard breaks down testing from device to duration.

	Limited	Prolonged	Permanent
Surface Devices			
Skin	Class I	Class I	Class I
Mucosal Surface	Class I	Class III	Class V
Breached or Compromised Surface	Class III	Class V	Class VI
External Communicating Devices			
Blood Path Indirect	Class IV	Class V	Class VI
Tissue/Bone/Dentin Communicating	Class IV	Class VI	Class VI
Circulating Blood	Class IV	Class VI	Class VI
Implant Devices			
All Devices	Class IV	Class VI	Class VI

It's recommended these test based on USP class.

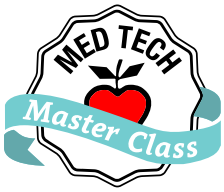
Based on the classification from above, there's then recommend testing protocols that should be used. This is just a suggestion and not a definitive requirement. Testing protocols will be dependent on a customer's own regulatory requirements or FDA submission requests.[2]

Test	Extracts	UPS Class					
		I	II	III	IV	V	VI
Systemic Injection Test	Sodium Chloride (Intravenous)	X	X	X	X	X	X
	Alcohol Saline (intravenous)		X	X	X	X	X
	Polyethylene Glycol (intraperitoneal)			X		X	X
	Vegetable Oil (intraperitoneal)			X	X	X	X
	Sodium Chloride (intravenous)	X	X	X	X	X	X
	Alcohol Saline (intravenous)		X	X	X	X	X
Intracutaneous Test	Polyethylene Glycol (intraperitoneal)					X	X
	Vegetable Oil (intraperitoneal)				X	X	X
Implantation Test	None				X		X

Medical rubber uses ISO 10993 biocompatibility test matrix for medical rubber.

ISO standard used a different testing recommendation. This testing is used for medical devices. ISO 10993 is to serve as a framework for biological evaluations, which also minimizes the number of exposures to test animals. Selecting the right device category, contact and duration can reduce unnecessary testing.[1]

Device Categories			Biological Effect											
Body Contact		Contact Duration	Cytotoxicity	Sensitization	Irritation / Intracutaneous	Acute Systemic Toxicity	Sub chronic Toxicity	Genotoxicity	Implantation	Hemocompatibility	Chronic Toxicity	Carcinogenicity	Reproductive / Developmental	Biodegradation
Surface Devices	Skin	Limited	x	x	x									
		Prolonged	x	x	x									
		Permanent	x	x	x									
	Mucosal Membrane	Limited	x	x	x									
		Prolonged	x	x	x	o	o		o					
		Permanent	x	x	x	o	x	x	o		o			
	Breached or Compromised Surfaces	Limited	x	x	x	o								
		Prolonged	x	o	o		o							
		Permanent	x	x	x	o	x	x	o		o			
Externally Communicating Devices	Blood Path, Indirect	Limited	x	x	x	x				x				
		Prolonged	x	x	x	x	o			x				
		Permanent	x	x	o	x	x	x	o	x	x	x		
	Tissue/ Bone/Dentin Communicating	Limited	x	x	x	o								
		Prolonged	x	x	x	x	x	x	x					
		Permanent	x	x	x	x	x	x	x		x	x		
	Circulating Blood	Limited	x	x	x	x		o		x				
		Prolonged	x	x	x	x	x	x	x	x				
		Permanent	x	x	x	x	x	x	x	x	x	x		
Implant	Tissue/Bone	Limited	x	x	x	o								
		Prolonged	x	x	x	x	x	x	x					
		Permanent	x	x	x	x	x	x	x		x	x		
	Blood	Limited	x	x	x	x	x		x	x				
		Prolonged	x	x	x	x	x	x	x	x				
		Permanent	x	x	x	x	x	x	x	x	x	x		



Medical-grade rubber compounds are different than FDA food grade.

There may be some confusion between FDA USP Class VI and FDA food grade materials. Class VI materials, which were discussed earlier, are tested according to the above protocols. FDA food-grade rubber materials typically comply with FDA 21 CFR 177.2600 “Rubber Articles Intended for Repeated Use.”

This standard list of chemicals, also referred to as Whitelist, has been approved for use with selective percentages. Typically, rubber compounds will start off with these types of formulations and then have them tested to Class VI or ISO 10993 protocols. Food-grade compounds undergo extraction testing only: one in water for contact with aqueous food and the other in n-hexane for contact with fatty foods. When someone orders rubber component, they should specifically request FDA Class VI or FDA food-grade in order to avoid potential confusion when just requesting an FDA component.

The FDA has rubber compound Master Files.

The FDA created a way for suppliers to submit trade secret or confidential information like rubber formulations. This would also include information like processing recommendation, any biological testing already performed and the risk assessment on the chemicals used in the formulation.

Remember rubber formulations are not like plastic compounds. Rubber formulations are made up of various chemicals and certain percentages. It’s not just one polymer like most plastics. With approval from the supplier, this allows FDA to access the file during the review process and have more information during a customer’s 510(k) submission.

There are levels of vendor raw material certifications.

There are many different levels of certification that raw material suppliers provide for medical-grade materials. Data sheets state that a material was tested to specific biocompatibility test. Other materials will provide a complete toxicology summary, which states the testing and the results. These materials are using less than 30-day implant materials or restricted materials. Suppliers may have tested one lot or have done testing periodically.

Materials that are considered implant grade or unrestrictive typically have material certification that provides some type of cytotoxicity and trace metal testing for each production lot. The level of certification provides typically is proportional to the cost of the material.

Standard Certificate of Analysis will list a warranted or expiry date. These are typically related to a date on which the vendor limits the ability for a customer to return material. This should not be confused with shelf life date. Many materials can run well past these dates and have the same physical properties. With proper controls and FIFO systems, manufacturers will assure material run will meet customers’ requirements.

References
1. ISO 10993-1, “Biological evaluation of medical devices – Part 1: Evaluation and testing within a risk management process”, June 16, 2016
2. USP Class Testing, April 14,2014, NAMSA Website