Resistance of common materials to irradiation

These tables show the average effects on polymers. Not all mechanical properties change by the same amount. In some materials the tensile strength may increase whereas impact strength or modulus may decrease and vice versa Occasionally, contradicting conclusions were found. In the tables this is displayed with a / sign.

Effect on materials can be influenced by:

- The size of the article
- The environment in which irradiation takes place
- The additives used in the compound
- The way a product is manufactured
- The dose rate that is applied

The information contained in this table is designed to be informative only. The actual effects on any given product or material cannot be predicted as there are too many variables to consider. Isotron strongly recommends that samples are tested after treatment to ensure they are still fit for purpose Legend regarding stability when sterilized between 10 and 25 kGy

++++	Excellent
+++	Good
++	Satisfactory
+	Weak
-	Unsatisfactory

Material

Rubbers and Elastomers	*Stability*	*Maximum dose*
Polyurethane rubber	++++	100-200
Natural rubber	+++	100
SBR (Styrene Butadiene Rubber)	+++	
Nitrile rubber	+++	200
NBR (Nitrile Butadiene Rubber)	++	
Polybutadiene	+++	
Acrinolitrile butadiene copolymer	+++	
Silicone rubber	++/+++	50 to 100
Neoprene rubber (polychloroprene)	++/+++	
Isobuthylene-isoprene copolymer	++	
Polyisoprene	+++	
EPR (Ethylene Propylene Rubber)	+++	
Vinylidene fluoride / hexafluoro propylene rubber	++	
Trifluoro chloro ethylene	+++	
Butadiene-vinylpiridine copolymer	+++	
Chloroprene rubber	+++	
Chlorosulfonated polyethylene	+++	
Polysulphide rubber	+++	

EVA rubber (Ethyl Vinyl Acetate)	+++	
Ethyl acrylate rubber	++	
Rubbers and Elastomers	*Stability*	*Maximum dose*
TPO (Olefinic Thermoplastic Elastomer 'Santoprene' nbsp;	++	
Polyester TPE (thermoplastic elastomer)	+++	
Styrenic TPE (thermoplastic elastomer)	+++	
Urethane TPE (thermoplastic elastomer)	+++	
Butyl rubber	-/+	20-50
Chloro butyl rubber -Bromo		-
butyl rubber	++	

Thermoplastics

Polysulfone	++++	>1000
PES (polyestersulfone)	+++	
PS (polystyrene)	++++	>1000
SAN (styrene acrylonitrile	+++	1000
Poly-alpha-methyl styrene	+++	
ABS (acrylonitrile butadiene styrene)	+++	1000
PS/polybutadiene blend	++++	
Alkene fumarate styrene copolymer	++++	
Styrene maleic anhydride copolymer	++++	
Styrene acrylonitrile copolymer	++++	
LDPE (low density polyethylene)	+++/++++	500
LLDPE (linear low density polyethylene)	+++	500
MDPE (medium density polyethylene)	+++	500
HDPE (high density polyethylene)	++++	
XLPE (crosslinked polyethylene)	++++	
PP (polypropylene, homopolymer)	+	<50
PP (polypropylene, copolymer)	++	<60
Poly (alkylene sulphide)	++	
PA (polyamide) "Nylon 6"	+++	
PA (polyamide) "Nylon 12"	+++	
PI (poly imide)	++++	100,000
PAI (polyamide imide)	++++	100,000
PEI (poly ether imide)	++++	
PEEK (poly ether ether keton)	++++	10,000
PAEK (Ultrapek)	++++	
PVC (poly vinyl chloride) and copolymers	++/+++	50
PVC polyol (plasticised PVC)	+++	
PVDC (polyvinylidene chloride)	+/++	50
PVDF (polyvinylidene fluoride)	+++	1000
PVOH (poly vinyl alcohol)	++	
Poly vinyl formal	+++	
Poly vinyl butyral	++++	
PVAc (poly vinyl acetate)	++++	
Poly vinyl methyl ether	+++	

Rubbers and Elastomers	*Stability*	*Maximum dose*
Thermoplastics		
Poly (vinyl carbazole)	++++	
Perfluoropropylene-vinylidene fluoride copolymer	-	
PTFE (poly tetra fluor ethylene) Teflon or Fluon	-	5
FEP (fluorised ethylene propylene)	++	50
EFTE (ethylene tetrafluor ethylene copolymer)	++	1000
PCFTE (poly choro trifluor ethylene)	+	200
Poly (chloromethyloxacyclobutane)	-	
PC (polycarbonate)	+/++	1000
Polyallyl diethylene glycol carbonate	++++	
Poly (bis-hydroxy phenyl propane carbonate)	+++	
PC ABS Alloy	++	
PC acrylic alloy	++	25
Polyphtalate carbonate	++	
Polyester carbonate	+++	50-100
Polyester (Mylar or Melinex)	+++	
Polyester copolymer	++++	
Cellulose esters-acetate and nitrate	++	
Polydimethyl siloxane	++	
Poly (methyl vinyl siloxane)	++	
Poly (methyl phenyl siloxane)	++	
EVA (ethyl vinyl acetate copolymer)	++	30
EVOH (ethyl vinyl alcohol)	+++	
PMMA (polymethylmethacrylate)	-/+	100
PMMA-PS copolymer	+++	
AMMA acrylonitrile methylmethacrylate copolymer	++	
Cyano acrylate	-	
Polyethyl acrylate	++++	
Acrylonitrile copolymer	++	
Acrylonitrile ethyl acrylate copolymer	++	
Acrylonitrile butyl acrylate copolymer	++	
Poly (dihydroperfluorobutyl acrylate)	++	
RTPU (rigid thermoplastic polyurethane)	++++	
Thermoplastics		
PETP (polyethylterepftalate)	++/++++	
PETG (polyethylene terelphtate glycol)	++++	1000
PBT (polybutyleen terephtalate)	+++	1000
PPO (poly phenyl oxide)	+++	
Polyphenyl sulphide	++++	
POM (polyacetal) (Delrin)	-	15
Polyacetal-polyformaldehyde and copolymers	-	
Polyformaldehyde	+	
LCP (liquid crystal polymer)	++++	
Poly (4-methylpentene)	+	

Rubbers and Elastomers	*Stability*	*Maximum dose*
Thermosets		
Epoxy resins	++++	
Phenol formaldehyde (Bakelite)	+++	>1000
Phenol formaldehyde resin filled with asbestos,	++++	
graphite or mineral flour	-	
Urea formaldehyde UF resins	++/+++	>1000
Aniline formaldehyde resin	++++	
Phenolic aniline resin	++++	
Melamine formaldehyde	++/+++	>1000
Casein formaldehyde resin	++++	
Furan resin	++++	
Silicone resin with glass fibre	-	
Polyphenylene sulphide resin	++++	
Polyimide	++++	100,000
PUR poly urethane	++++	
Polyether urethane	++++	
Polyester resin filled	++++	
Polyester styreen modified	+++	
Textiles		
Polyester-Terylene or Dracon	++	
Cellulose acetate "Dricel" and "Tricel"	++	
Cellulose propionate	++	
Cellulose nitrate	++	
Cellulose acetobutyrate	+++	100
Ethyl cellulose	++	
Cellulose (viscose rayon)	++	
Acrylic yarn-Orlon, Acrilan and Courtelle	++	
Wool	++	
Silk	+	
Nylon 6 and 6:6	+/+++	
Cotton	+	
Adhesives		
Araldite (epoxy based)	+++	
Vinyl type e.g.: polyvinylacetate	++	
Pressure sensitive adhesive	+	
PUR-adhesive	+++	
EVA-copolymer	++	
Oils and greases		
Mineral oils and diesters	+++	
Silicone oils	++	
Natural oils	+	
Commercial Greases	++	
Metals	++++	

Product Groups

Packaging materials

Most packaging materials behave satisfactorily at the sterilizing dose of 25 kGy. Polypropylene and coated cellulose films (Cellophane) are embrittled at 50 Guy and should be used with considerable caution. Polyester film "Melinex" or "Mylar" is te most stable with the exception of Du Ponts H Film which has high stability. The ionic polymer Surlyn "A" is probably only suitable for doses up to 1000 kGy. LDPE and PVC based films can produce odours on irradiation.

The permeability changes produced in packaging materials on irradiation are very small and can be ignored. PET is used for gamma irradiation because of its low temparature resistance.

Paper and cardboard

Loses machanical strength at low doses but are serviceable up to at least 50 kGy

Wood and cork

Wood loses mechanical strength but is stable up to at least 100 kGy Cork is quite stable to radiation and doses of 1000 kGy produce small changes.

Printing ink and paint films

It is unusual to find colour changes in printed material, occasionally a change of shade may be found. The behaviour of paint films can be predicted from a knowledge of the polymers used in their formulation. The most stable coatings are made from phenolic and apoxy compounds. Halide coatings eg: PVC should be avoided. Certain paints such as unsaturated polyester can be cured using radiation.

Inorganic fillers, glass and concrete.

There is little measurable change in inorganic materials at doses up to 10,000 kGy, apart from slight colour changes. Glass can change colour at doses above 1 kGy, depending on the raw materials. Borosilicate typically turms brown, AR glass can stay clear. More radiation stable glasses are available which only show small colour changes. Concrete is very stable, no change at all. It is used as a shielding material.