

Soling Materials Guide

The adjacent table presents for the shoe technologist the basic properties of most of the solings he or she is likely to encounter. It will be of help in the selection of new or alternative materials.

It must be emphasised that the range of solings covered by each polymer type is very wide. This is especially so in the case of solid vulcanised rubber, where types included in the general summary range from inexpensive highly filled soling to premium quality carbon or silica reinforced rubbers. Special purpose, eg oil resistant, compounds are also included.

Section 5 explains each property in detail. Section 6 gives notes on adhesion in a separate table. The inside back cover gives guidance on identification of the most common types.

The notes

1. Wear resistance. The figures are 'specific durability' results based on practical wear trials carried out by SATRA. Specific durability is derived from volume loss relative to the SATRA standard reference soling.

2. Hardness. The following arbitrary ranges have been used:

Very soft <45 IRE-ID
 Soft 45 - 54IRHD
 Medium 55 - 74 IRHD
 Moderately hard 75 - 84 IRHID
 Hard 85-951RI-ID
 Very hard >95 IRHD

3. Crack resistance. The purely mechanical forms of tracking are considered here, not cracking due to chemical attack, extreme dryness in the case of leather, etc.

Soling	Form	Normal Specific Gravity (density) range	Wear resistance (Note 1)	Hardness (Note 2)	Crack Resistance (Note 3)	Slip resistance	Other properties	Other comments
Leather	Solid - bends, cut soles, built units & insert moulded	0.95- 1.05	0.3 - 0.8 Fair - Moderate	Hard	Good	Can be low initially on dry surfaces and, when heavily saturated, on wet surfaces	Not waterproof but can be impregnated to alter properties	Has good aesthetic appeal anti reputation for being able to 'breathe' (ie water vapour permeable). Normally reserved for dress shoes. The cutting, trimming and finishing necessary add further to the high cost.
Leatherboard	Solid sheet, cut soles, built units	1.05 -1.15	0.4 - 1.0 Fair - Moderate	Hard	Good	Satisfactory	Relatively stiff material. Adhesion should be checked	Suitable for footwear requiring a thin, firm sheet soling material. Properties are a compromise between those of leather and resin rubber
Resin rubber	Solid sheet, cut soles, built units & insert moulded	1.25 -1.40	0.5 - 1.2 Fair - Moderate	Hard	Good	Good though some finishes affect performance when new		Good cutting, trimming and edge finishing properties. Good aesthetics. Principal sole material for court shoes.
Vulcanised rubber	Solid - units, moulded on or facer skin	1.05 -1.35	1.0 - 3.0+ Moderate -Excellent	Soft-Moderately Hard	Good - Excellent	Good	Heat resistant. Oil resistant grades available.	Excellent general purpose soling in every respect. Can be compounded to suit requirements. Price dependant on type of compound and base polymer. Compounding and processing is expensive. Versatility leads to diverse application.
Vulcanised rubber	Cellular - sheet, units and moulded on (sponge)	0.3- 1.1	0.5 - 1.0 Fair-Moderate	Soft - Medium	Good	Good	Except sponge, expands on mould opening. Heat shrinkage should be checked	Difficult to mould direct to shape (unless sponge, with intercommunicating cells) so soles are often cut from sheet or produced as casters. Good material for casual footwear. Sponge needs a solid rubber facer.
Crepe rubber	Solid- sheet and built units	0.9	1.5 - 2.2	Very soft (but temperature sensitive)	Very good	Good on dry surfaces, can be low on wet surfaces	Sensitive to oils, heat and direct sunlight. May shrink slightly	Weight advantage over other solid materials offset by inability to core out. Very limited in form and colour. Good material for casual footwear. A natural and uncompounded product.
Thermoplastic rubber (TR)	Solid - units and moulded on	0.9- 1.1	0.8 - 1.5 Moderate - Good	Soft - Hard	Good (especially at low temperature)	Very good	Very sensitive to oils and solvents. Can wear to a ragged appearance.	The most rubbery of the thermoplastics. Wide range of compounds. Popular as a cheaper and lighter alternative to solid vulcanised rubber in fashion and children's footwear but not tough enough for sustained heavy duty use.
Thermoplastic rubber (TR)	Cellular	0.8-1.0	0.5 - 1.4 Fair-Good	Soft		Very good	Relatively stiff parallel to the mould axis	Prone to form mould flow lines and delamination can be a problem. High grip can cause friction melting in vigorous use. Thin coring ribs prone to collapse.
PVC	Solid - units, moulded on and some sheet	1.15 - 1.35	1.3 - 1.9 Good	Medium	Satisfactory (can be poor at Low temperature)	Satisfactory at moderate hardness, low at high hardness	Oils and solvents leach out normal plasticisers embrittling material. Wears very smooth.	Easily moulded. Good economical general purpose soling. Oil resistant grades can be produced (see From PVC blends). Usually has a glossy surface finish. Under pressure from the environmental lobby for perceived, if not actual, risks.
PVC	Cellular - units and moulded on	0.7 - 0.9	1.2 -1.9 Good	Very soft - Soft	Satisfactory	Satisfactory		As above for solid PVC except that some versions avoid the glossy surface finish and thereby have better aesthetic appeal.
PVC blends	Solid - units and moulded on	1.15 - 1.20	2.2-2.6 Good - Very good	Medium	Satisfactory	Satisfactory at moderate hardness	Weirs very smooth. Oil, fat resistant versions available	Properties and price dependant on types and proportions of modifiers used. Blending can improve oil resistance, durability and flex crack resistance.
PU reaction moulded	Cellular - units and moulded on, infill of dual density soles	0.4 - 0.6	2.0 - 4.0 Good - Excellent	Very soft - Moderately hard	Satisfactory but sensitive to tread design and off ratio mixing	Good but may be affected initially by applied surface finishes	Polyester version oil resistant but vulnerable to hydrolysis. Polyether version hydrolysis resistant but not usually oil resistant, may absorb water	Most durable of the low density cellular solings - comparable with or better than many solid soles. Good set resistance and dimensional stability. Very versatile. Can be used with a wearing facer of high density solid PU, TPU or vulcanised rubber. Careful process control important. Appearance of moulded features marred by small voids at surface edges due to entrapped air in mould. Mould release agent necessary, soles then need degreasing.
PU reaction moulded	Solid - facer on dual density soles	0.9- 1.1	3.6 - 6.6 Excellent	Soft - Medium	Satisfactory - Good	Moderate, good with pattern	Polyester version oil resistant but vulnerable to hydrolysis. Polyether version hydrolysis resistant.	Usually facer (wearing surface) on dual density PU soles. Careful process control important. Appearance of moulded features marred by small voids at surface edges due to entrapped air in mould. Mould release agent necessary, soles then need degreasing.
Thermoplastic PU	Solid - units and moulded on	1.15- 1.25	3.0-6.0 Excellent	Medium - Very hard	Good, including harder grades	Good, hard grades can be slippery but less relevant in special applications	Oil resistant versions available	For special sports soles (eg football, cricket) moulded as single or multiple components. Separation between such components is sometimes a problem in wear. Softer compounds may be used as facer on dual density soles. Material costs expensive but performance and appearance are both very good. Maybe blended in any ratio with PVC
Thermoplastic PU	Cellular - units	0.75 - 1.00	1.5 - 3.0 Good - Excellent	Medium	Good	Good	Local density depends on proximity to injection point	High material price only partly offset by expansion-to moderate density. Considered a premium everyday footwear sole material, offers good properties with good appearance.
EVA crosslinked	Cellular - sheet, built units, caster or moulded units and midsoles	0.2 - 0.4	0.1-0.7 Fair - Moderate	Very soft - Soft	Generally excellent more risk with thick units	Low when wet without pattern	Expands on mould opening. Heat shrinkage should be checked	Difficult to mould direct to shape so soles are often cut from sheet or produced as casters. Good material for very lightweight casual footwear and sports shoe shock absorbing midsoles. Composition varies widely - often blended with SBR or polyethylene. Generally more durable than micro vulcanised rubber of comparable density. Wide range of colouration possible.
EVA crosslinked	Cellular - sheet, cut soles, built units	0.65 plus	0.6 - 0.8 Fair - Moderate	Hard	Good	Satisfactory	Heat shrinkage should be checked	Suitable for footwear requiring a thin, firm but lightweight sheet soling material. Other comments as for low density EVA.
Nylon (PA)	Solid units	Nylon 6: 1.11 - 1.14 Nylon 12: 1.01 -1.05	Not applicable	Very hard	Adequate with correct design	Low	Can wear to sharp edge or burr	Some sports applications eg football boot soles, spiked running shoe foreparts. Also some women's units, these require a different wearing surface to avoid slip and metal reinforcement of slender heels.
'Pebax' (EEA thermoplastic elastonier)	Solid units	1.0- 1.1	Not applicable	Very hard	Satisfactory	Low, due to hardness	Good low temperature impact resistance, sensitive to hydrolysis	Can combine thinness with stiffness and flexing endurance for special application. Used for football soles and ski boots. Relatively expensive compared to TPU.
'Hytrel' (EEC thermoplastic eta sterner)	Solid units	1.2	Not applicable	Very hard	Satisfactory	Low, due to hardness	Good low temperature properties, abrasion resistance	Can combine thinness with stiffness and flexing endurance for special application, particularly where cold flex crack resistance is required. Used for football boots. Relatively expensive compared to TPU.