A puncture or cut resistant protective sole for footwear made of woven fiber plies and flexible bonding agent disposed between adjacent woven fiber plies to define an alternating layered composite, wherein the flexible bonding agent penetrates into voids of each woven fiber ply and bonds fibers of each woven fiber ply to fibers within the same ply.
FLEXIBLE PUNCTURE RESISTANT SOLE

TECHNICAL FIELD

[0001] The invention relates to flexible puncture resistant sole for use in safety footwear to reduce the likelihood of injury, and particularly a flexible sole made of alternating plies of woven fabric and a flexible bonding agent material such as thermo-formed resin, rubber or plastic.

BACKGROUND OF THE ART

[0002] The sole of footwear worn by people nowadays is often made of resin material, such as foam rubber or plastics, and possibly leather. Due to its elastic and pliable properties, it can provide those who wear the shoes with soft and comfortable feeling. Yet, conventional shoes also have some disadvantages. When the wearer treads on sharp-pointed articles, such as metal nails, they can easily pierce sole and injure the wearer’s foot.

[0003] To prevent injury, some manufacturers mount a mild steel sheet or stainless steel sheet on the sole to guard against puncture or cutting injury of the foot. However, the relative rigidity and inflexibility of the metal sheet causes the wearer much inconvenience and the superior heat transfer properties of metal generally make the wearer’s feet too hot in hot environments or too cold in cold environments. Metal sheets are relatively difficult to properly bond to other footwear components with adhesives, bonding agents or stitching for example.

[0004] An object of the invention is to provide a puncture resistant sole structure that has improved flexibility, compatible heat transfer characteristics and at an economic cost.

[0005] Further objects of the invention will be apparent from review of the disclosure, drawings and description of the invention below.

DISCLOSURE OF THE INVENTION

[0006] The invention provides a puncture and cut resistant structure in a multi-ply sole of shoes formed of a number of woven fabric layers and alternating plies of a flexible bonding agent, such as resin, plastic or rubber adhered to each other in a composite material. Preferably the composite material can be formed by thermo compression of the woven ply and bonding agent with each other. The material for the fiber woven ply may be a high-crystallized polymer fiber of polyamide having a high shearing strength and tensile strength, for example with tensile strength being five times as strong as that of the mild steel wire. The fiber woven ply may be woven with a common weave pattern where warp and weft yarns alternate in a dense crisscross pattern, with the function of inhibiting piercing or cutting. When in contact with sharp-pointed articles, the woven ply being bonded with the bonding agent or rubber ply by thermo compression serves to strengthen the piercing resistance function of the composite layered material. The bonding agent bonds the fibers of the woven ply together and fills in voids between the woven fibers to inhibit movement of the fibers which would permit a sharp point to penetrate the woven ply.

[0007] The sole is made of several woven plies laid upon one another with bonding agent between them, such as rubber plies which can be bonded together with thermo-compression. The overall thickness of the combined fiber woven plies and rubber plies thermo-compressed together is about from 3 mm to 5 mm.

[0008] When the sole of the present invention is used the wearer is better protected from the risk of injury from sharp or pointed articles while the sole can also be used as an ordinary sole or as a shoe-pad. The composite puncture resistant sole can also be disposed on the ordinary sole and the shoe-pad or otherwise sandwiched in between the shoe-pad and the ordinary sole, so that the overall thickness increased as well as the efficiency of puncture and cut prevention. The sole of the present invention feels lightweight and flexible in use while remaining strong to resist injury.

DESCRIPTION OF THE DRAWINGS

[0009] In order that the invention may be readily understood, one embodiment of the invention is illustrated by way of example in the accompanying drawings.

[0010] FIG. 1 is an exploded view showing the multiple layers of woven fabric and rubber as a bonding agent of which the sole is manufactured;

[0011] FIG. 2 is a sectional view through a shoe with the sole of the present invention treading on a sharp-pointed article;

[0012] FIG. 3 is a detailed sectional view of the woven and rubber bonding agent layers bonded by thermo compression.

[0013] FIG. 4 is a perspective view showing the common weave or crisscross weaving pattern of the woven layer.

[0014] Further details of the invention and its advantages will be apparent from the detailed description included below.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0015] As shown in FIGS. 1-4, the present invention relates to a puncture preventive structure for the sole of footwear, comprising several woven fiber plies 1 and a layer of bonding agent such as plastic or rubber plies 2 which can be bonded by mutual thermo compression. The material for the woven fiber ply 1 is a high-crystallized polymer fiber polyamide having high shear strength and high tensile strength, for example with tensile strength five times that of the mild steel wire. The woven fiber ply 1 is woven in a common or staggered densely crisscrossed pattern, to improve the resistance to puncture by sharp-pointed articles. The woven fiber plies 1 are bonded with the bonding agent ply 2 which can be rubber or plastic preferably by thermo-compression. Through thermo compression the voids or gaps in the woven fiber ply 1 are filled and smoothed over by the infilling of the bonding agent 2, and yarns or fibers are bonded together to resist movement to strengthen the resistance to piercing of the composite layers. When compared with a conventional sole made of a metal sheet, which makes the wearer feel heavy and cumbersome, the softness and flexibility of the woven fiber ply 1 and bonding agent or rubber ply 2 in the sole of the present invention is advantageous, with a high strength puncture resistive property.
The overall thickness of these woven fiber plies 1 and rubber or plastic plies 2 thermo-compressed with one another is about from 3 mm to 5 mm. When the present invention having a thickness from 3 mm to 5 mm applies pressure to a nail tip of 0.8 mm diameter to make a piercing test, the pressure being applied must be at least 120 Kg. Therefore, the present invention can be pierced through when high loads are applied. Yet when a man or woman is ordinarily walking, running or even making violent movement such as jumping, the load applied by the foot when touching the ground is far less than 120 kg.

Although the above description relates to a specific preferred embodiment as presently contemplated by the inventor, it will be understood that the invention in its broad aspect includes mechanical and functional equivalents of the elements described herein.

I claim:

1. A puncture or cut resistant protective sole for footwear comprising:
   a plurality of woven fiber plies; and
   a plurality of flexible bonding agent disposed between adjacent woven fiber plies to define an alternating layered composite, wherein the flexible bonding agent penetrates into voids of each woven fiber ply and bonds fibers of each woven fiber ply to fibers within the same ply.

2. A sole according to claim 1 wherein the bonding agent is selected from the group consisting of: rubber; plastic; and resin.

3. A sole according to claim 1 wherein the bonding agent is thermo-formable.

4. A sole according to claim 1 wherein the woven fiber plies comprise polyamide.

5. A sole according to claim 4 wherein the woven fiber plies comprise high-crystallized polymer fiber polyamide.

6. A sole according to claim 1 wherein the woven fiber plies have a common weave pattern.

7. A sole according to claim 1 wherein the thickness of the sole is in the range between 3 mm to 5 mm.