RESEARCH COMPARISON OF FOOT PLANTAR PRESSURE ON POLYURETHANE VISCO ELASTIC FOAM INSOLE AND EVA INSOLE MATERIALS

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The viscoelastic cushion insoles respond to the unique curves and pressures of our foot with every movement whether walking, running, playing, or exercising. Initially NASA, USA had developed viscoelastic foam insole to support astronauts during the heavy G force applied to the body during space flight. Nowadays ¼ inch thick layer of viscoelastic foam sandwiched between two layers of different types of foam are available commercially at a high cost. In our country, viscoelastic PU foams as cushion inserts for shoes are imported from China. But the available materials are not scientifically characterized and optimized for the composition of PU for application as an insole for treating foot abnormalities. In this project PU, the viscoelastic foam was prepared using standard polyols and dissociates used by industries to prepare memory foam mattresses. The additives which are physiologically and environmentally safe were used.

Keywords: plantar pressure, PU viscoelastic foam, EVA foam, peak values, footwear stability, cushion factor, cushion energy

INTRODUCTION

Footwear is one of the common commodities being used by all kinds of persons from child to aged and from poor to rich. Foot comfort on wearing footwear is the basic expectation from consumer's point of view other than protection and style (Socaciu *et al*., 2010). Improper footwear may lead to heel or knee or hip or back pain. Insole, one of the most important components in footwear, helps to protect the complex bony structures of the lower extremity from damage and for uniform distribution of pressure and increased contact area under the foot while standing, walking and running and thus prevent pressure spots stated that structure orthotics are custom-made shoe inserts which serve to correct or relieve misalignment and/ or pressure areas of the foot and redistributes pressure and provides shock absorption. Therefore, there is a need for new material that can be used alone as inserts in shoes in 3 to 5 mm.

Materials Used as Cushion Insole

Polymer elastomers and foams are widely used to meet the material properties of an insole and in the sock. Among various polymers, ethylene-vinyl acetate (EVA), polyurethane (PU), and rubber-based materials are widely used in footwear. Shock absorption and dimensional stability are more important materials properties of the insole. PU foams and elastomers are proved as the most effective materials for shock absorption in footwear. Foam provides some shock attenuation and gives good pressure distribution, feels soft to the touch. An undesirable property of foams is “compression set” in which repeated loading causes the walls of the cells to collapse, leading to a loss of material thickness, elasticity, and energy absorption capacity. In contrast to PU foam, polyurethane elastomer is a soft, non-porous rubbery material. The elastomer provides good shock attenuation and pressure distribution; reasonably resistant to compression set but does not feel soft. The disadvantage of PU elastomer is the absence of pores which contribute much to the resilience of material during deformation. Therefore,

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porous viscoelastic material will fill the gap between PU elastomer and foam. In the present research work, new polyurethanes were synthesized and developed into viscoelastic foam sheets with good mechanical strength to resist.

Advantages and Disadvantages of Currently Available Materials

The foams are cellular materials, which may be either open or closed cell. Open-cell materials resemble a sponge, where the bubble walls are incomplete, allowing free exchange of air in and out of the material. In closed-cell materials, air or some other gas (usually nitrogen) is trapped within minute bubbles, which become pressurized when the material is stressed, the gas pressure aiding in the elastic recovery. In contrast to the various forms, polyurethane elastomer is a soft, non-porous rubbery material. An undesirable property of many foams is “compression set”, in which repeated loading causes the walls of the cells to collapse, leading to a loss of material thickness, elasticity, and energy absorption capacity. Foam materials differ in their resistance to compression set, due to their chemical makeup and their initial stiffness. Polyurethane foams were found to be more resistant to compression set than polyethylene foams of similar density the compression set.

Comparison of PU Foam and EVA Foam Materials

The main purpose of cushion insole in shoes is to reduce the peak plantar pressure and increase the total foot contact area while standing and walking. The effectiveness of cushion insole can be determined by using high-resolution sensors in the form of the mat which can scan the plantar surface and the treks can the software can measure.

Figure 1. Foot scanner and PU Foam insole

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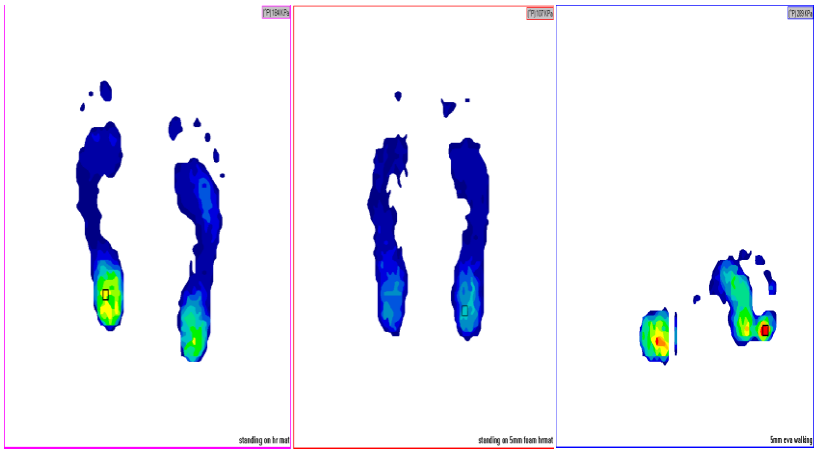

Figure 2. Foot pressure comparison along with PU Foam EVA insole

DISCUSSION

Footwear insole hardness (Shore A), density, compression set, cushion energy, cushion factor water absorption were determined by the SATRA test method. A further modification was done in the composition by changing the concentration of isocyanate and polyol and other additives such as surfactant, tin catalyst, and crosslinkers (Wood, 1982; Hock, 1998; Kaushiva, 1999). In the first trial PU, the viscoelastic foam was low resilient and very softness and water absorption was higher. Next, we modified the above chemical composition in trial second sample number 7 and 8 PU Visco elastic memory foam was higher resilience than the first trial, tensile strength was determined by SDDC lab CLRI by SATRA standard test method. Now the hardness was very higher than the first trial samples so we changing the density of the foam composition, the filler is added to increase the density for our requirements (Pratt *et al*., 1986). Second trial ratio 100: 80 and 100: 85 level was optimum for our requirements; the above two ratio foam was developed and now the foam was high hardness and optimum resilient that first trial samples. 10 mm PU Visco elastic memory foam was developed and determined by SATRA Standard test methods in SDDC Lab CLRI CHENNAI INDIA. Hardness (Shore A) compression set, density, cushion energy and cushion factor, water absorption and desorption test, tensile strength test were evaluated. These values were compared with CLRI ideal value sample ratio 100: 85 PU viscoelastic memory foam was identified and better for shoe insole. FTIR, NMR spectroscopy, and foot scan test methods were determined by standard test methods. The newly developed viscoelastic memory foam was determined to pressure studies and measurements were evaluated by GIAT Lab CLRI Chennai India. The pressure was compared with current available EVA shoe insoles, these foot scan pressure values were noted and foot pressure distribution compared with another ordinary insole. From the above results, PU viscoelastic memory foam was better than other EVA, PU, vegetable leather insole, and cork insoles (Pratt *et al*., 1986; Pratt, 1988). The newly developed PU viscoelastic will be mainly used for cushion insert for therapeutic footwear and it will control the foot pain, heel shock absorption and distribute the foot pressure, give the additional cushion support to the foot arches (Mihai *et al*., 2008; Socaciu *et al*.,

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2010). PU viscoelastic insole gives the foot shape during walking, and running, this insole environmentally and eco-friendly shape. The project is useful for the footwear industry.

CONCLUSION

Through viscoelastic PU foams available as cushion mattress and pillow, the newly developed insole based on PU memory foam were scientifically and characterized and optimized properties for application in insole /sandals in 5mm to 10mm thickness. This insole may be used in footwear for flat foot, high arched foot, dropped metatarsals, planter facilities. Callus and corn due to peak plantar pressure in the diabetic foot can be treated by pressure-relieving and sock reducing effects of viscoelastic foam Physical characterization such as infrared spectroscopy, scanning electron microscopy, thermal analysis, and Fscan plantar pressure measurement were determined. This insole is better for therapeutic footwear for as cushion insole than EVA and some other leather, rubber insole.

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