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Polymer Footwear for Diabetic Foot Patients

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Abstract – ***Recent times have seen an upsurge in the statistics of type 2 Diabetes (diabetes mellitus) in India. The symptoms and effects associated with it can be far-reaching sometimes. This paper includes a discussion about the diabetic footwear. This is a condition which is caused by nerve damage in patients with acute diabetes which may result in infections, lacerations and finally an amputation of the affected foot. To take care of the foot, a specialized range of footwear can be custom-made for different patients according to the level of infection caused in the foot. Here, different polymeric materials that are generally used in the manufacturing of diabetic footwear and their different combinations are dealt with. The final and the most suitable combination will be concluded with an explanation of how the footwear provides comfort as well as protection to the damaged foot, and a brief discussion to choose the best footwear for a diabetic foot patient.***

I. INTRODUCTION

One of the many common diseases -Diabetes, often referred to by doctors as diabetes mellitus, describes a group of metabolic diseases in which the person has high blood glucose (blood sugar), either because insulin production is inadequate, or because the body's cells do not respond properly to insulin, or both. The diabetic foot is a victim of nerve damage, micro- and macrovascular disease, and faulty healing, mechanisms that without proper care can lead to amputation or the cutting of the foot. Therefore, performance requirements of footwear are much higher than before, necessitating the use of new polymers and fillers to meet these needs. The level of footwear compounding has increased dramatically. Briefly the four aspects of diabetic footwear are:

- Covering – to prevent injury from heat, objects etc.
- Padding – to lessen the effect of muscle-wasting and to give a soft surface for any hard, bony projections which can be felt
- Moulding – to increase the weight-bearing area to take weight off the affected area.
- Rigidity – to reduce the effect of shearing stress, to stabilize the foot and correct mobile deformity

II. EXPERIMENTAL WORK

2.1 Materials

The chief materials to be used during this research are ethylene vinyl acetate (EVA), polyurethane foam (PU) and silicon rubber, Styrene Butadiene Rubber (SBR) and Ethylene Propylene Diene Monomer (EPDM). The upper of the footwear will consist of PU-coated fibre. Silicone rubber flows easily and can be molded, pressed or extruded using relatively low amounts of energy, simplifying production. PU can easily be recycled, and the PU industry has teamed up with carpet manufacturers to turn recycled PU foam into 80% of bonded carpet cushion. EVA is a standard material used for outsole manufacture. The formulation, compounding and testing will be followed by the shoe designing process with the help of a last.

2.2 Equipment

For the compounding of the above mentioned materials, a two-roll mil or and internal mixer is to be used. The silicon used is RTV Silicon which can be directly molded with the help of a mould or last. The next part is the testing part where basic tests are to be done on each sample of polymer like hardness, tensile strength and elongation. After the footwear is made, a number of tests like adhesion, wear resistance, tearing resistance, energy absorption, metal penetration test, tensile resistance and elongation, bally resistance, Sole abrasion, Bennewart flexing movement, Water vapor permeability, Electrical conductivity and antistatic test, Resistance of shoe to cold conditions, Abrasion, Slip resistance test and Thermal insulation test.

III. RESULTS AND DISCUSSION

The results are evaluated on the basis of requirements on diabetics' foot management program. The selected footwear material should have a balanced hardness (not too soft, not too hard), good abrasion resistance, easy moldability, high flex, good balance of tensile and elongation, resistance to water permeability and above all, has to have low impact of environmental conditions.

The aim of this research is to signify the role of polymers in this range of footwear and reason out the requirements of footwear especially suited for diabetic patients. Since there is no general design for making a diabetic footwear sample, this range of footwear calls for a more extensive approach for the compounding and design of the shoe, according to the variations in the degree of harm to the foot. This research will not only clarify this aspect but will also raise awareness about the diabetic problems related to foot.

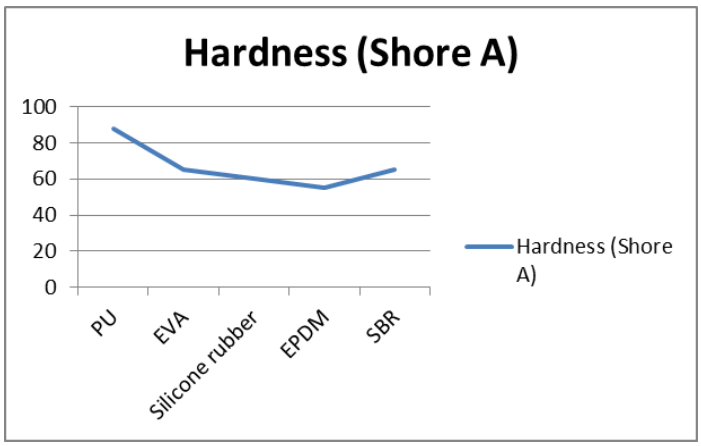

Figure 1. Hardness

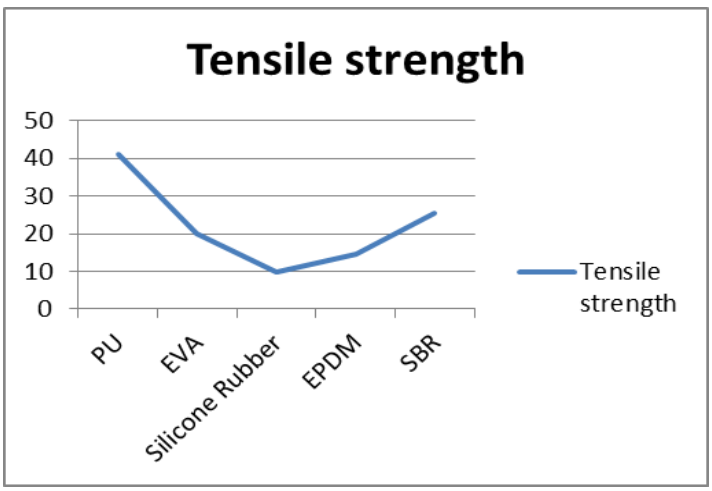

Figure 2 Tensile Strength

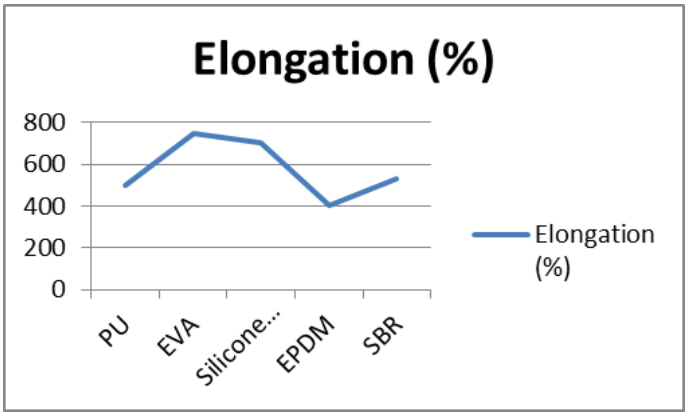

Figure 3. Elongation

IV. CONCLUSION

It can be concluded from the research that not only a technical background for polymers is a necessity to carry out the experiments but awareness about diabetes is also essential. The polymers used in this research are eco-friendly enough and suffice for their use. Manufacturers of footwear companies may add a different range of customized healthcare footwear under which this research may find its use. The products may be commercially viable and patient-friendly as well as be recycled after use.

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