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Polymer Materials for Diabetic Footwear

[1]Kajal Anjaria, [2]Prof. B. H. Shah, [3]Prof. Bhakti Patel

[1, 3] Rubber Technology Department, L.D.College of Engineering, Ahmedabad-380015.
[2]Chemical Engineering Department, L. D. College of Engineering, Ahmedabad-380015
[1]kj2810@gmail.com,[2] chemldce@yahoo.com [3] patelbhakti8423@yahoo.com

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 thesis 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. In such cases, the foot has to be taken care of during the duration of treatment. A specialized range of footwear can be custom-made for different patients according to the level of infection caused in the foot. This thesis mainly deals with the different polymeric materials that are generally used in the manufacturing of diabetic footwear and their different combinations. Further, there will be a discussion regarding the satisfactory conditions required for such kind of footwear according to which the footwear materials will be compounded, moulded and tested to check for the credibility of a particular polymer combination. 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.

Keywords: *Diabetic Foot, Diabetic Footwear, Polymers and Rubber Compounds, Desired Properties*

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. Worldwide, the rates of diagnosed diabetes are rising, especially in developing nations. The diabetic foot is a victim of nerve damage, micro- and microvascular disease, and faulty healing, mechanisms that without proper care can lead to amputation or the cutting of the foot. Complications, such as foot ulcerations are common with patients of diabetes. It is estimated that >5% of these patients have a history of foot ulcers, and the cumulative lifetime incidence may be as high as 25%. Some 85% of all amputations are preceded by foot ulcers. The effective treatment of a patient with diabetic foot complications requires a multidisciplinary approach. Polymers see use in diabetic footwear mainly because of the various properties they can exhibit. As the footwear for diabetes patients is customized, and the type of shoe to be designed varies from person to person according to degree of harm caused to the foot, a variety of polymeric materials can be blended and used in order to suit the patient.

II. EXPERIMENTAL 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.

III. EXPERIMENTAL 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.

IV. RESULTS

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 mouldability, high flex, good balance of tensile and elongation, resistance to water permeability and above all, has to have low impact of environmental conditions.

V. DISCUSSION

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.

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.

Figure 1: Hardness

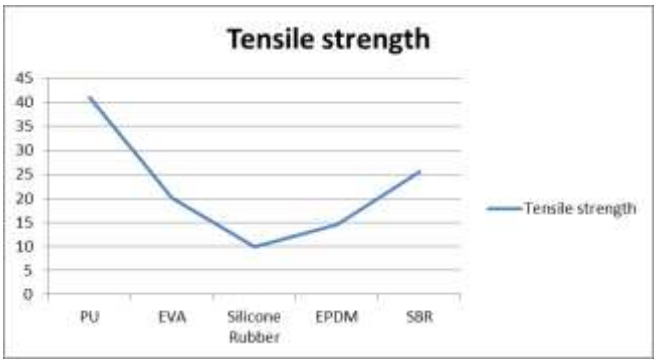

Figure 2: Tensile strength

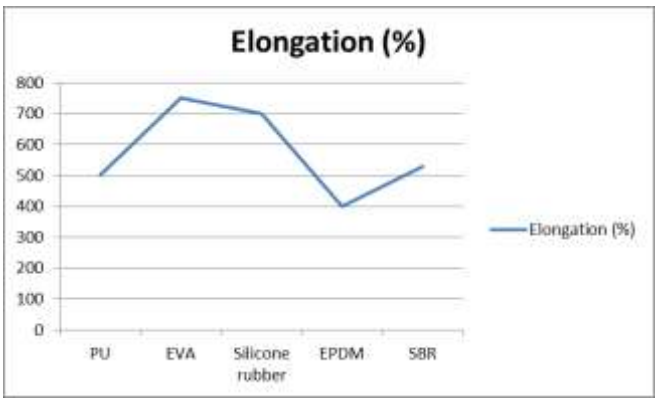

Figure 2: Elongation

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