DEVELOPMENT OF NOVEL POROUS VISCOELASTIC POLYURETHANE INSOLES AND STUDY OF THEIR EFFICACY IN REDUCING PLANTAR PRESSURE

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INTRODUCTION

Many foams and viscoelastic materials are used in shoes to replace the shock-absorbing and pressure distributing functions of natural fat pad beneath the foot that was lost due to diabetes, arthritis, age or overuse. In a series of long term wear tests on a variety of insole materials, it has been reported that after prolonged use, however, the PU elastomers retained most of their properties of shock absorption whereas foams deteriorated [1,2]. In the present work, effort was made to develop viscoelastic porous polyurethane sheet of 3 - 6 mm thickness having the properties of both PU elastomer and foam by using phase inversion method for fabrication of sheets and studied their physical and cushioning properties for application in therapeutic footwear.

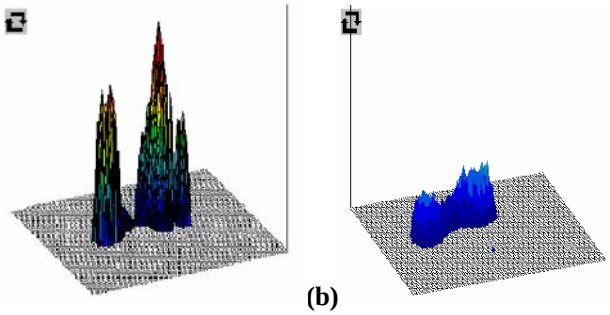
METHODS

Ten types of polyurethane PU sheets were developed using Desmophan, 8078 obtained from Bayermaterial Science, Germany. In each type of sheet polymer concentration and solvent volume are changed. Formation of porous and fibrous structures within the sheets was made possible without any chemical additives through coagulation of PU solution directly into sheet by phase inversion method using water as nonsolvent [3]. Cushion energy, cushion factor, hardness, density, compression set (CS), tensile strength, tensile strain, Modulus of elasticity (E) were measured using SATRA (UK) test methods.

Further, therapeutic footwear incorporated with developed PU insoles were fabricated and distributed for regular use to diabetic patients at risk of developing foot ulcers. The peak plantar pressures (PPP) and total contact areas were measured using In-shoe F-scan system, (Tekscan, USA) on day 1 and after 3 months on walking with therapeutic footwear.

RESULTS AND DISCUSSION

Results of physical and cushion properties of PU sheets for application as insole in therapeutic footwear were shown in Table 1. Values obtained for 15 to 35 % W/V of PU are in the ideal range. Especially hardness which is the importance parameter for insole was obtained between 17- 22 shore A and % CS which is the major drawback of foams is obtained less than 2 %, showing the resilience of PU sheets. PPP were lower and total contact areas were higher in case of therapeutic footwear both on day 1 and after 3 months. (Figure1).



(a) **(b)**

Figure 1: 3-D view of plantar pressure distribution in patient No.1 after 3 months (a) on bare foot, (b) on wearing therapeutic footwear

CONCLUSIONS

This study and patients reports support the use of developed PU insoles for therapeutic footwear applications and orthosis fabrication in diabetic patients.

REFERENCES

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Table 1: Physical and Cushion properties of developed PU sheets

Sample No.	Sample code	Thickness, mm	Hardness, Shore A	Density (g/cm^3)	Compression set (%)	Cushion Energy, N.mm	Cushion factor	E, MPa
1	15-cpu-1h	3.39	11-15	0.2432	0.0	31.9	7.7	0.6500
2	15-cpu-1	4.57	6-9	0.2053	0.5	53.6	6.2	0.4272
3	20-cpu-1h	5.8	17-22	0.2924	1.6	71.4	5.8	1.0750
4	20-cpu-1	4.42	17-22	0.3124	1.9	48.7	6.5	0.7085
5	25-cpu-1	4.89	15-19	0.2810	1.6	55.9	6.3	0.8233
6	30-cpu-1	4.93	15-20	0.3397	0.2	65.8	5.4	1.0459
7	35-cpu-1	5.31	18-22	0.3800	1.2	71.7	5.3	1.0091
8	40-cpu-1	5.97	25-30	0.3818	3.4	80.5	5.3	1.4492
9	45-cpu-1	5.69	28-32	0.4580	4.2	59.0	6.9	1.4343
10	50-cpu-1	6.06	29-33	0.4875	3.5	61.6	7.0	1.9836