

Clinical Application of RTV Elastomers

MICHAEL T. WILSON, C.P.O.¹

Urethane elastomers have been used extensively in prosthetics and orthotics for more than twenty years for the fabrication of expanded urethane SACH feet and cosmetic covers, hydraulic and pneumatic ring seals, and various high-impact resistant components in articulated mechanisms. Utilization of urethane elastomers has been confined generally to industrial or wholesale application, primarily because of the precise and demanding environmental control systems necessary to insure proper vulcanization. Atmospheric pressure, prepour temperature and postcure elevation, as well as proportional exactness of the multicomponent systems have made this elastomeric group impractical for application in clinical laboratory or resale fabrication. However, recent developments in urethane elastomers have increased greatly the practicality of clinical application. It is the purpose of this article to discuss the new developments, and to illustrate their applications in clinical prosthetics and orthotics.

The word elastomer means synthetic rubber, or rubber-like material, and pertains primarily to physical, rather than chemical, molecular configuration. Urethanes are the most widely used elastomers because of their incredibly high tensile strength, chemical inertness, abrasion resistance, and adhesive qualities.

Unlike flexible plastomers, such as polyester and epoxy resins, urethanes are resilient, having the capacity to absorb force by stretching, and then returning to their original shape and size after the force has been reduced. This resiliency, or forgiving quality, is often useful in the successful design and fabrication of prosthetic and orthotic appliances.

Unlike the widely used Silastic elastomers, such as Dow 384 and 385, urethanes are highly resistant to abrasion, have a high tensile strength, and, thus, are not nearly as susceptible to wear and tear as other elastomers. Urethane elastomers are not only cohesive, as Silastics are, but they will adhere to almost all other materials. Its adhesive qualities make it ideal for flexible lamination because of the extensive chemical association with the nylon or fiberglass reinforcement agent.

The specific urethane elastomer discussed in this article is called Lynadure¹. Basically, it is a formulation of flexible epoxy plastomers and medium density urethane elastomers. This particular combination of epoxies and urethane results in a material possessing the best qualities of both components, and which is best described as resilient plastic. Working temperature is between 40 and 120 deg F. It is a two-component system, with a mixing ratio of 10 parts compo-

nent-A resin to 3 parts component-B curing agent. No exotic mixing or metering equipment is necessary. The components can be mixed by hand in an uncontrolled environment. Working time, or "pot life", is about 7 minutes. Demolding time at room temperature is 45 minutes, which can be reduced significantly with heat. Complete vulcanization and detoxification can be achieved by postcuring at 180 deg F. for 4 hours. The viscosity of Lynadure can be raised to any extent by adding fillers such as cellulose acetate fibers, microballoons, glass beads, etc. The viscosity can be lowered by adding up to 50 percent TGW primer to component A prior to mixing with component B. Thinning will help facilitate rapid saturation of thick laminations.

Clinical Applications

The discussion of RTV urethane elastomer application will be limited here to partial foot prostheses and wrist immobilization orthoses. Figure 1 represents prosthetic socket treatment for a transmetatarsal amputation. Talocrural, subtalar, intratarsal and tarsal-metatarsal joints are left intact and functional. Therefore, the UCBL insert approach (1, 2) to foot stabilization is appropriate in designing the prosthetic socket. Not only does the UCBL insert type socket provide adequate support to the foot, but it also provides an ideal foundation on which to build a prosthesis. The primary objective in providing a transmetatarsal prosthesis is to protect the integrity of the part of the foot that is left, and provide for some degree of flexion and extension through the artificial metatarsal-phalangeal joints. The lamination technique can be considered to be an air cushion socket in reverse.

The rigid portion is laminated first with 10 percent 4134 and 90 percent 4110 polyester resin, and allowed to cure. Prior to this first lamination a prefabricated

tongue (1½"-2" wide) is secured in place on the model (Fig. 2) before application of the inner PVA bag. This is to facilitate a smooth interfacing of tongue and socket against the limb. A new PVA sleeve is applied and the nylon proximal portion of the insert is impregnated with Lynadure (Fig. 3) thinned by adding between 10 and 25 percent TGW Primer. The monoelastic SACH foot is then contoured and attached to the socket. Figure 4 represents a monoelastic molded urethane SACH foot contoured on the superior surface to accommodate the inferior configuration of the UCBL insert socket.

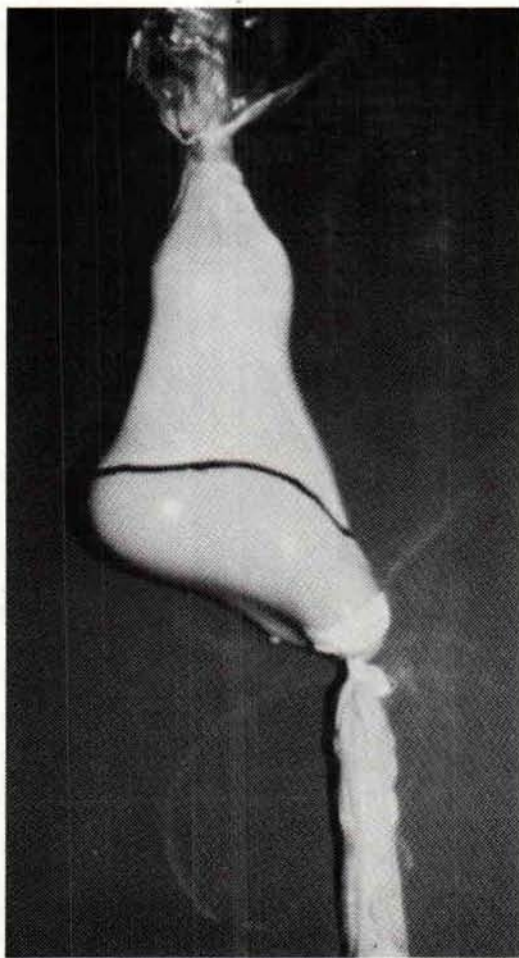


Fig. 1. Use of Lynadure in providing prosthesis for transmetatarsal amputation.



Fig. 2. Prefabricated tongue secured in place on the model before the first lamination.

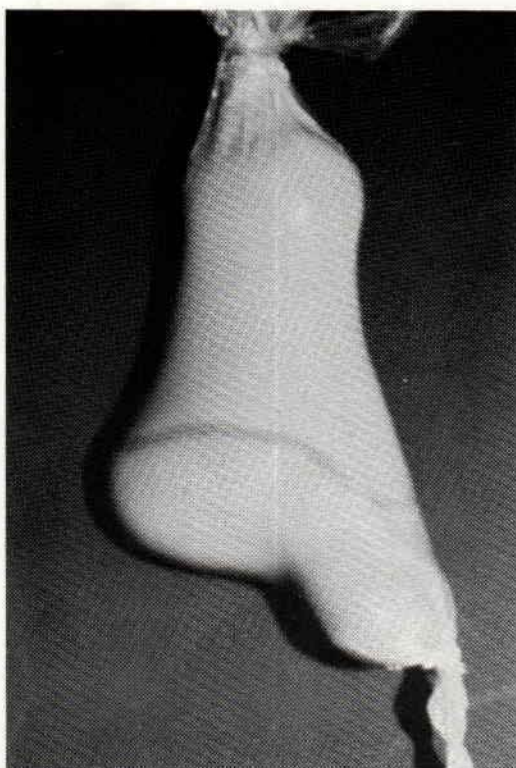


Fig. 3. Photograph of assembly showing the flexible proximal portion of socket and the rigid distal portion.



Fig. 4. A monoelastic SACH foot that has been contoured to match the inferior surface of a UCBL shoe insert type of socket.

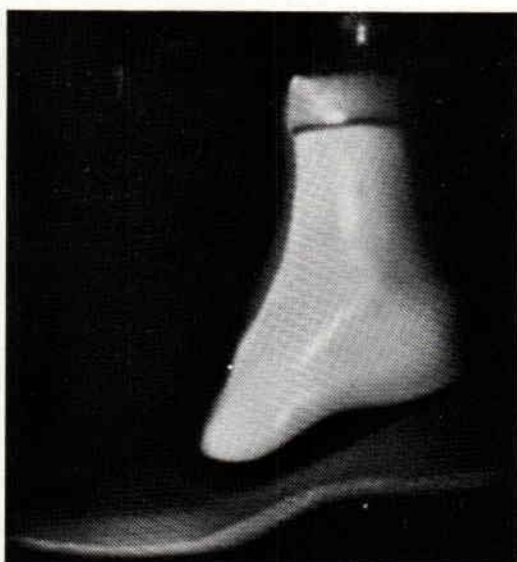


Fig. 5. The correct relationship between the SACH foot and the shoe insert type of socket.

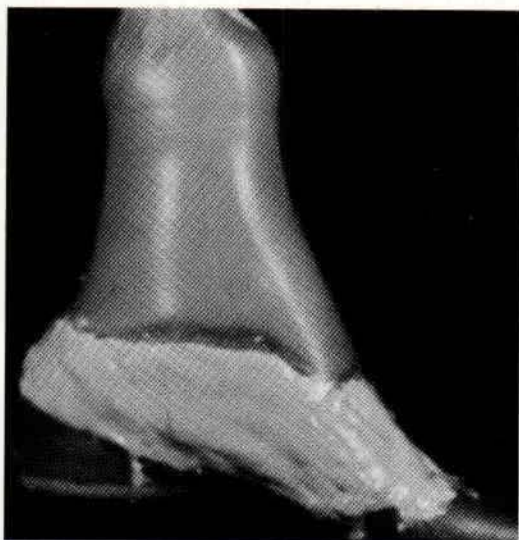


Fig. 6. The voids are filled with a mixture of Lynadure and microballons, glass beads, etc., which also forms a bond between foot and socket.

Figure 5 illustrates the correct relationship between the SACH foot and socket. The void between the two surfaces, including the length discrepancy between the extended socket and the ideal location of the artificial MP joints can be filled with Lynadure mixed with fillers (Fig. 6). This also permanently adheres the foot to the socket. The Lynadure is allowed to cure and is smoothed by sanding. Figure 7 illustrates the final lamination of the foot and socket. The SACH foot should be sized by brushing on a thin layer of Lynadure to minimize the migration of air from the foot into the lamination. Usually two layers of IPOS stockinet or two Knit-Rite cosmetic hose will suffice as reinforcement, depending on the structural specifications for the final lamination. Additional reinforcement can be added to the plantar surface of the SACH foot, particularly through the "toe break"

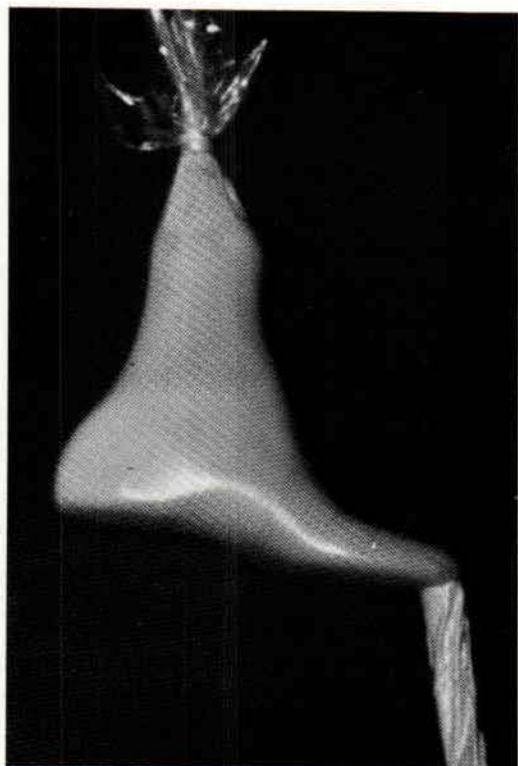


Fig. 7. Final lamination stage.

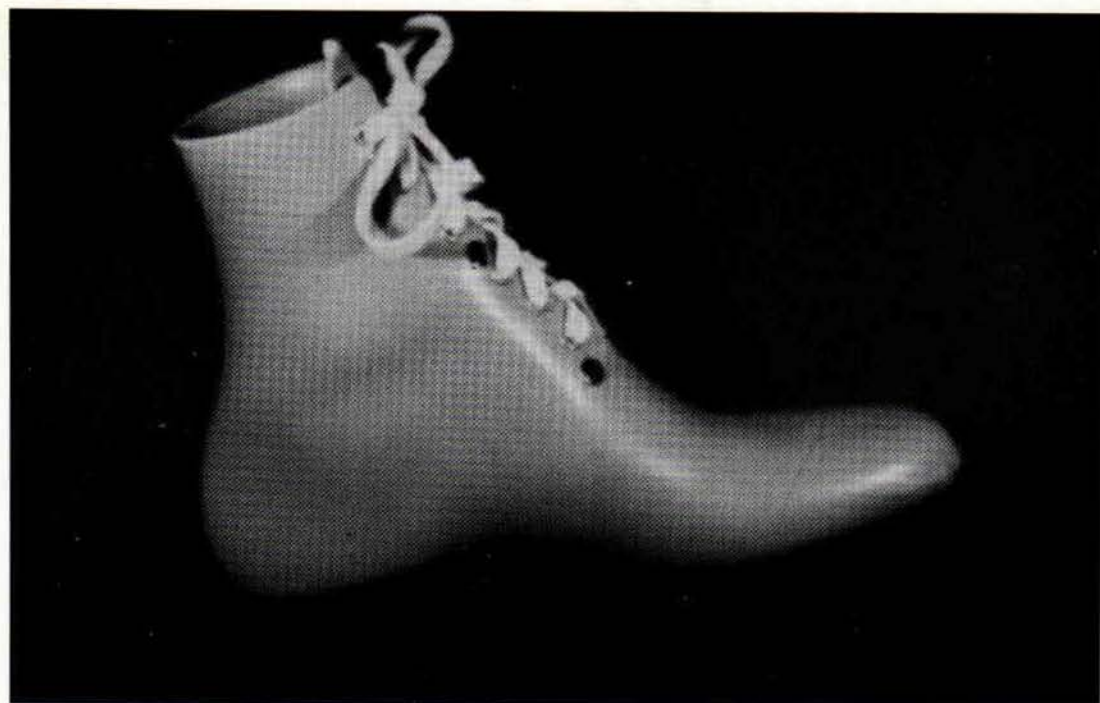


Fig. 8. The finished prosthesis with laced closure.

area. Figure 8 represents the finished prosthesis with a frontal lace closure.

It is important to recognize the fact that all material used in this fabrication sequence are chemically compatible. The final lamination not only chemically adheres to the polyester socket, but also to the urethane SACH foot, making it essentially one piece. Because Lynadure is flexible and resilient, it does not interfere with the normal function of the foot. Because the abrasion resistance and tensile strength of Lynadure is so great, the cross-section of the prosthetic socket can be greatly reduced from that of Silastic lamination, and, thus, permits easy insertion and withdrawal of the prosthesis in and out of the shoe. Subsequent modification of the socket is facilitated by the heat sensitive characteristic of Lynadure. Over pressure sensitive areas, the Lynadure can be heated, and stretched. After cooling, the socket wall will maintain its new dimension.

Figure 9 represents a positive cast for an orthosis for a traumatic and permanent medial displacement of the carpals relative to the forearm, with a related neuropathy. This particular orthosis will have a dorsal lacer opening, so the closure tongue should be placed over the dorsum of the hand, wrist, and forearm before application of the inner PVA bag as seen in Figure 10. Neolon or padded vinyl can be sewn over the cast and tongue as interfacing (a liner). The seam should be over the center of the tongue so that it can be cut away after lamination (Fig. 11). Directly over the tongue and interfacing, 2-4 layers of nylon stockinet are laminated with Lynadure (Fig. 12). In this application, the Lynadure can be thinned as much as 50 percent, depending on the degree of flexibility required of the orthosis. After the Lynadure has cured (about 45 minutes at room temperature), it can be cut off the cast and outfitted with the appropriate

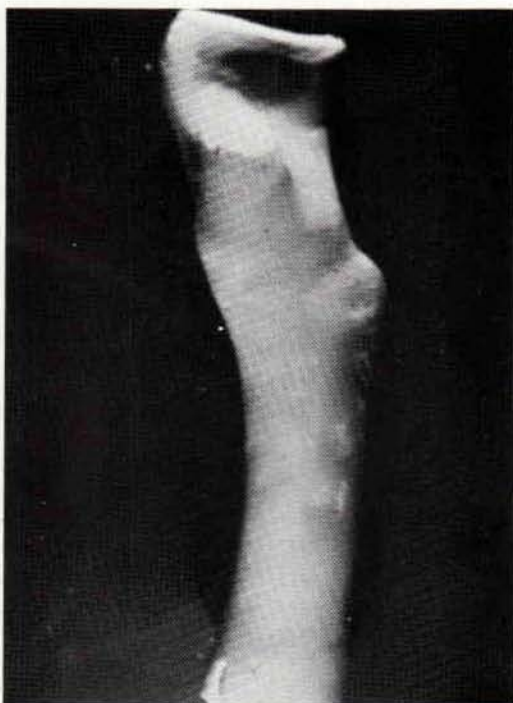


Fig. 9. Positive cast for an orthosis for medial displacement of the carpals.



Fig. 10. The closure tongue for the orthosis is placed over the dorsum of hand, wrist, and fore-

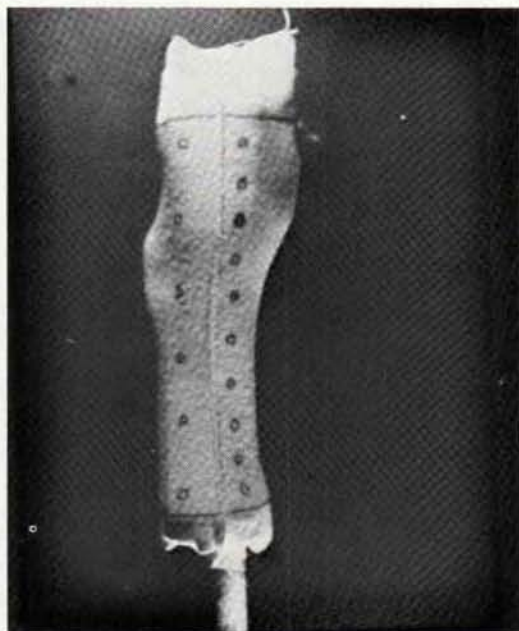


Fig. 11. Padded vinyl is sewn over the cast and tongue to provide an interfacing. The seam should be over the center of the tongue so that the vinyl can be cut away easily after lamination.

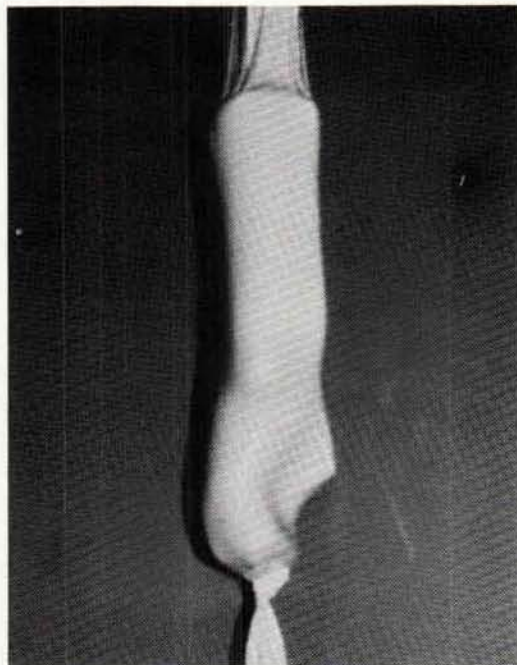


Fig. 12. Two to four layers of nylon stockinet are laminated over the cast with Lynadure.

closure system (Fig. 13). Because Lynadure adheres directly to the interfacing, no sewing or glueing is necessary, except for the tongue. Any amount of stabilization or freedom of motion through the wrist and hand can be controlled by the trimlines, tension of the closures, durometer of the Lynadure, and cross-sectional thickness of the lamination. As in the partial foot prosthesis, modifications can be made by heating the lamination, and pushing it outward to the desired position. Accessibility permitting, modifications can be made by cutting or sanding the lamination.

Summary

The qualitative description of Lynadure and the two clinical applications mentioned in this article should give the reader some insight as to the unique characteristics of Lynadure, and its potential applicability in clinical prosthetics and orthotics. The urethane elastomeric group is rather new to our field, and its ultimate usefulness depends on the imagination and resourcefulness of individuals willing to examine new materials and their practical applications. Lynadure is currently being evaluated by the Veterans Administration as a molding rubber for cosmetic restorations. It is also being tested as a material suitable for extractable air cushion socket inserts. Applications in soft sockets have proved very successful.³ In regard to integumental application, Lynadure can be brushed directly over the endoskeletal urethane foam covering (USMC, Hosmer/Dorrance, Otto-Bock) to increase the resistance of the foam to tearing, discoloration, and water absorption.

Footnotes

¹Medical Center Prosthetics, Inc., 6955 Alameda Road, Houston, Texas 77021.

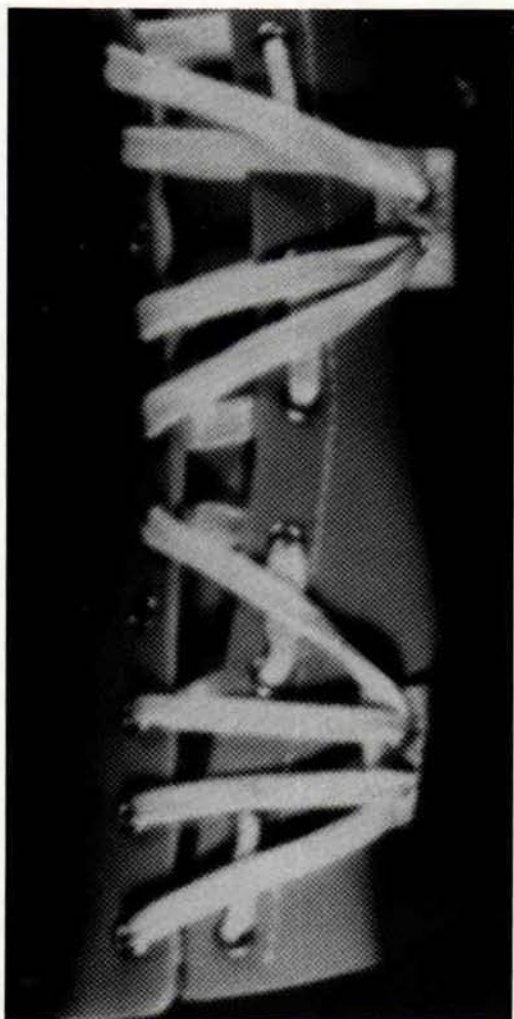


Fig. 13. The finished orthosis.

References

1. Henderson, W.H., Campbell, J.W., "UC-BL shoe insert, casting and fabrication," *Bulletin of Prosthetic Research*, 10:11, 214-235, Spring 1969.
2. Isman, R.C., Inman, V.T., "Anthropometric studies of the human foot and ankle," *Bulletin of Prosthetic Research*, 10:11, 97-129, Spring 1969.
3. Wilson, Michael T., "Spenco-Lynadure soft inserts," *Orthotics and Prosthetics*, 32:3, 21-24, September 1978.