Biomimetic Compression Garment for Muscle Recovery

Lead Investigators

Qianhong Wu, PhD, Professor of Mechanical Engineering, Director of the Cellular Biomechanics and Sports Science Laboratory

Bo Li, PhD, Associate Professor of Mechanical Engineering

Background and Unmet Need

Athletes worldwide employ early and on-going compression therapy to greatly improve short-term recovery as well as long-term outcomes for those engaging in strenuous physical activity.

Medically, applying targeted pressure through compression has been found to boost blood circulation and reduce inflammation, expediting healing.[1] A recent study further showed such therapy improves both perceptual and performance indices of exercise recovery.[2]

Compression garments on the lower limbs are increasingly popular for those athletes who wish to improve performance, reduce exercise-induced discomfort, and reduce the risk of injury. These garments are a go-to for athletes seeking quicker recovery between training sessions.

While multiple products exist to provide a muscle stimulation / recovery solution, they typically include complicated electrical systems that are expensive to manufacture and expensive for the at-home consumer.

Opportunity

Drs. Wu and Li have developed a biomimetic mechanical cell-pack system which has been shown to provide an effective and affordable solution for muscle recovery. Their biomimetic system *does not require electrical connection or support;* it delivers controlled compression and resistance to the relevant muscle groups through their proprietary cell pack design.

The cell pack design comprises a network of compartments containing the working fluid, which moves through the system via channels between cells. The movement of this fluid is analogous to the blood circulation in the cardiovascular system, modulating heart rate and dilation levels throughout the arterial tree, supplying the blood flow needs of specific muscle groups.

The novel cell pack technology may be integrated within wearable performance garments and incorporated into low-profile athletic garments. The device's actuation requires no external power or integrated circuits; the cell pack exploits the fundamentals of fluid flow; simply moving one's arm or any body part on which the device is worn will activate the device. The inventors foresee athletic recovery and repair as only the first of multiple therapy and recovery applications.

As a platform for several forms of athletic physical therapy garments, the cell pack system may be integrated with any state-of-the-art performance fabrics to create a wearable garment that can be worn virtually anywhere on the body. Possible products can be weighted to promote strength and conditioning applications and can incorporate elastic resistance for beneficial recovery stimulation, compression, and massage, automatically targeting the activated muscle.

---

[1] Beliard S, Chauveau M, Moscatiello T, Cros F, Ecarnot F, Becker F. Compression garments and exercise: no influence of pressure applied. J Sports Sci Med. 2015 Mar 1;14(1):75-83. PMID: 25729293; PMCID: PMC4306786.

[2] O'Riordan, S.F., Bishop, D.J., Halson, S.L. et al. Compression-induced improvements in post-exercise recovery are associated with enhanced blood flow and are not due to the placebo effect. Sci Rep 12, 16762 (2022). https://doi.org/10.1038/s41598-022-21029-2

Continued on back

The sports compression wear market was estimated to be valued at $1.27 billion USD in 2023 and is expected to grow to $2.95 billion by 2032 at a 10.1% compound annual growth rate.[3] The Villanova cell pack technology is an element within this market, providing a novel solution for athletic recovery.

Unique Attributes

- Biomimetic design that modulates heart rate and dilation levels throughout the arterial tree to supply the required blood flow for the specific needs of muscle groups.
- Composed of commercial elastomers with tunable mechanical strength and surface properties. The properties of the elastomer are optimized to control for fluidic resistance and pressure distribution across cells. Likewise, the surface properties of the elastomer-based cells are optimized for seamless integration with the supporting fabric.
- Highly viscous (non-Newtonian), highly temperature-responsive fluid, which is bio-safe and cost-effective.

Applications

Immediate commercial application for sports recovery garments. The technology is being further studied and developed for physical therapy applications for more advanced conditions, including stroke patient recovery.

Stage of Development

Prototype Developed.

Technology Readiness Level 5: Technology Validated in Relevant Environment.

Intellectual Property

United States Patent Application Published as US 2023/0372185 A1, November 2023.

Licensing and Collaboration Opportunity

Villanova University is seeking a licensee or collaborator to commercialize the invention.

INSTITUTIONAL CONTACT

Amanda M. Grannas, Ph.D.
Vice Provost & Chief Research Officer
+1 610.519.4881
amanda.grannas@villanova.edu

L2C PARTNERS CONTACT

Merle Gilmore, MBA
+1 610.662.0940
gilmore@l2cpartners.com

Alex Toglia, MS
+1 610.937.1067
toglia@l2cpartners.com

[3] Sports Compression Wear Market Size, Share, Growth, and Industry Analysis, By Type (Compression Socks, Compression Under, Compression Arm Sleeves, Compression Tops), By Application (Men, Women), Regional Insights, and Forecast To 2032, Business Research Insights, January 2025.