Sustainable Medical Technologoies

Smart Shape Memory Textiles for Medical Application

Priyanka Gupta, Bipin Kumar*

Department of Textile and Fibre Engineering

Abstract

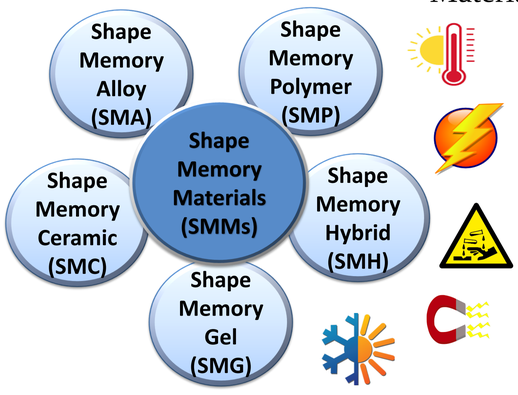
Recent progress on smart materials is driving researchers to create novel textile products for various applications. Herein, we are utilizing the potential of an intelligent material, i.e. Shape Memory Alloy and Shape Memory Polymer, in the form of wire and filament and then integrating it into the fabric structure for developing **Responsive Textiles**.

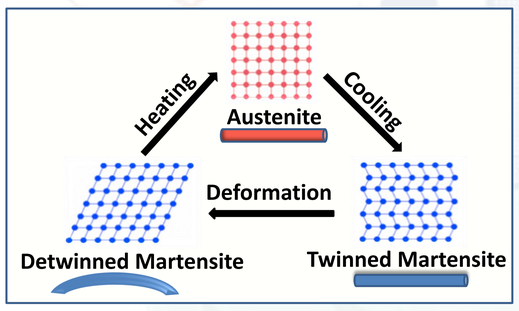
Applications: Self–repairing auto bodies to kitchen utensils, switches to sensors, intelligent packing to tools, smart fabrics, heat shrinkable tubes for electronics or films for packaging, intelligent medical devices.

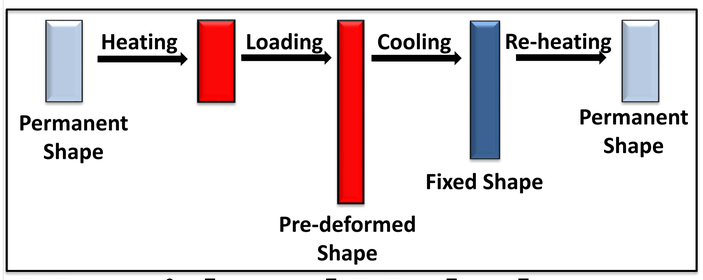
Introduction

RESPONSIVE MATERIALS

Material behaves differently in presence of stimulus.



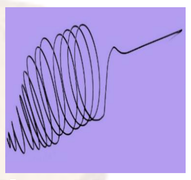




Some materials possess a unique property named as *shape memory effect* and is the ability of the material to switch over to its original condition when subjected to right stimulus. SMMs have been used in textiles to convert a normal fabric into a responsive textiles.

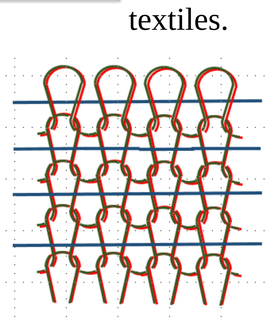
Materials and Methods

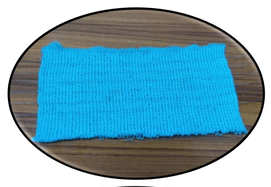
Acrylic Yarn

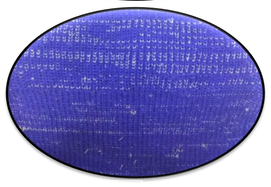


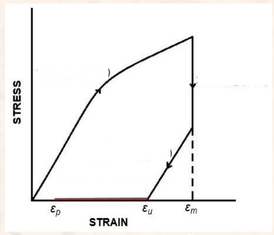
Shape Memory Material

Knitting





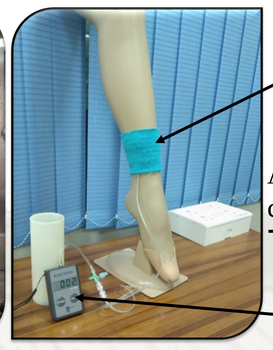




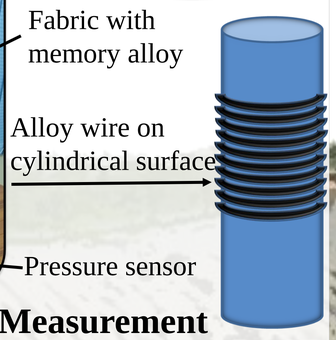
$$Shape\ Fixity = \frac{\varepsilon_u}{\varepsilon_m}$$

$$Shape\ Recovery = \frac{\varepsilon_u - \varepsilon_p}{\varepsilon_u}$$

Recovery force Measurement

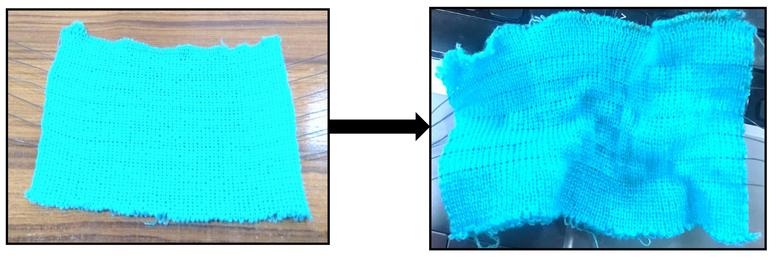


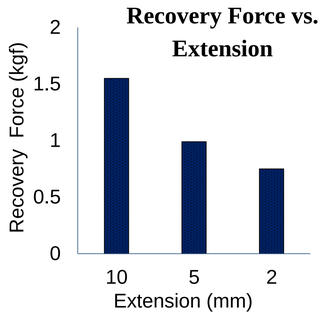
Pressure Measurement



Results

Recovery Force

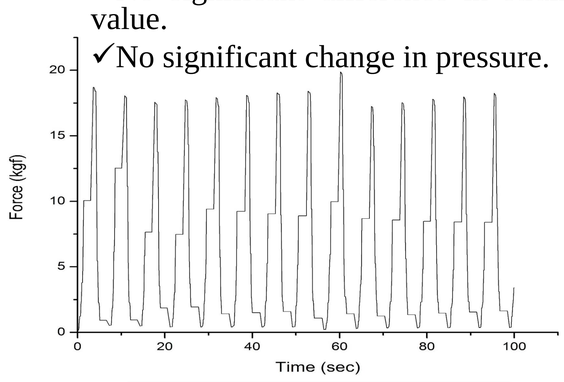


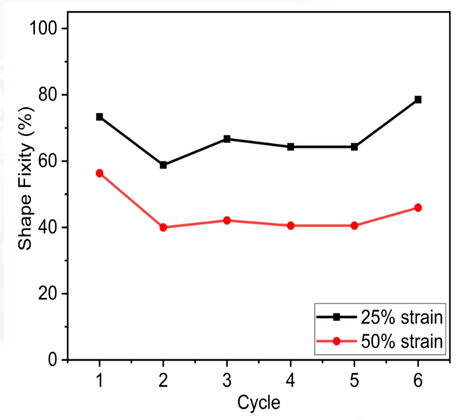


Dynamic Pressure Control

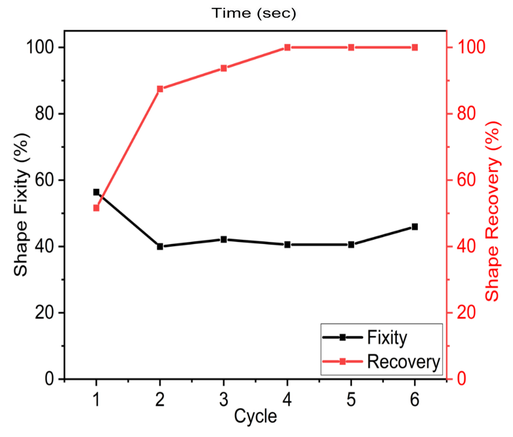
✓No significant difference in strain value.

✓No significant change in pressure.

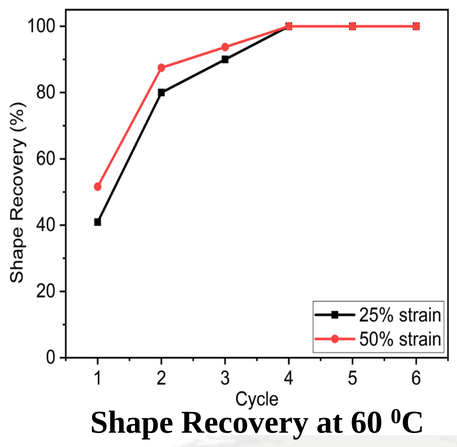




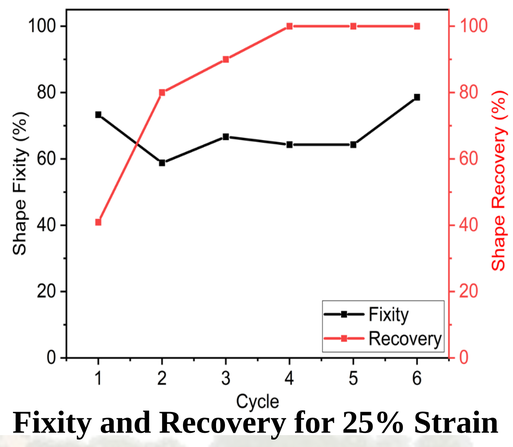
Shape Fixity at 60 ^{0}C



Fixity and Recovery for 50% Strain



Shape Recovery at 60 ^{0}C



Fixity and Recovery for 25% Strain

- ✓ Recovered length after every cycle is higher than the previous length.
- ✓ Applied strain and fixed strain reduce as number of cycle increases.
- ✓ Shape fixity is higher for lower initial strain than for higher initial strain.
- ✓ As SMP is dependent on applied strain, optimum strain has to be determined.

Conclusions

- ➢ SMA integrated textile exhibit excellent recovery stress.
- ➢ It can be used for making pressure garments giving more freedom in controlling or readjusting pressure externally.
- ➢ Shape memory textiles can also be used as a Self-fitting garment.

Industrial Significance

Smart textiles are an emerging field which can fulfill a lot of technological needs that can lead to breakthroughs in the field of healthcare, specialty garments and other smart applications.

Technology Readiness Level

The product would require optimization specific to their respective end uses.

References

1. B. Kumar, J. Hu, N. Pan, H. Narayana, Materials and Design, 97 (2016) 222-229.
2. Q. Meng, J. Hu, Y. Zhu, J. Lu and Y. Liu, Smart Mater. Struct., 16 (2007) 1192-1197.
3. Q. Meng, J. Hu, L. Y. Yeung, Y. Hu, J. Appl. Polym. Sci. 111 (2008) 1156-1164.
4. L. Jing, J. Hu, Fibres & Textiles in Eastern Europe, 18 (2010) 39-42.
5. M. Ahmad, J. Luo, M. Miraftab, Sci. Technol. Adv. Mater. 13 (2012) 1-7.

Acknowledgement

I would like to acknowledge Department of Science & Technology (DST), India for their financial support. (Project Code: MI01695 & RP03454G).
I would also acknowledge the guidance and support received from Dr. Bipin Kumar, Department of Textile Technology, IIT Delhi