3D Printing of Kirigami Conductors

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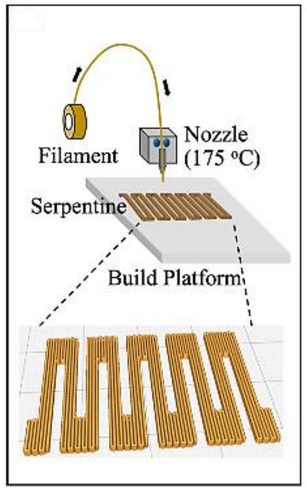
Motivation

- Kirigami is utilized in the manufacturing industry to improve durability, versatility, and elongation.
- These kirigami structures are 3D printed with an Ender Pro printer and a conductive filament.
- Japanese art form, kirigami, means “cut” and “paper”, which in this application turns two-dimensional into three-dimensional deformation.

Research Aim

- Our hypothesis for this project is that during elongation, the conductor will have the highest stress at the location of deformation.
- The objective of this research is to study the relations between tensile properties and the geometry of kirigami conductors.
- Following thorough data from various tensile tests, the research team will determine the evolution of conductivity during the deformation process.

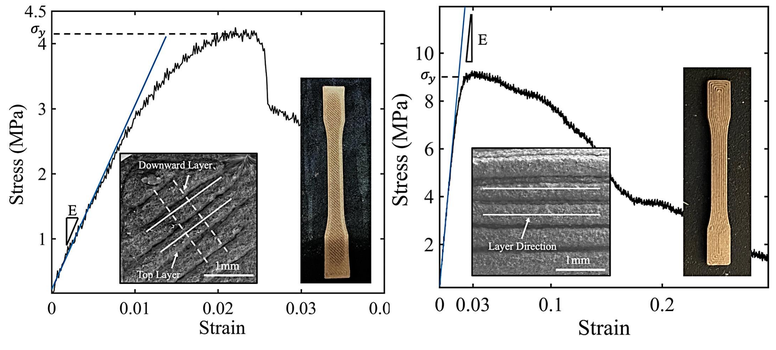
Methods



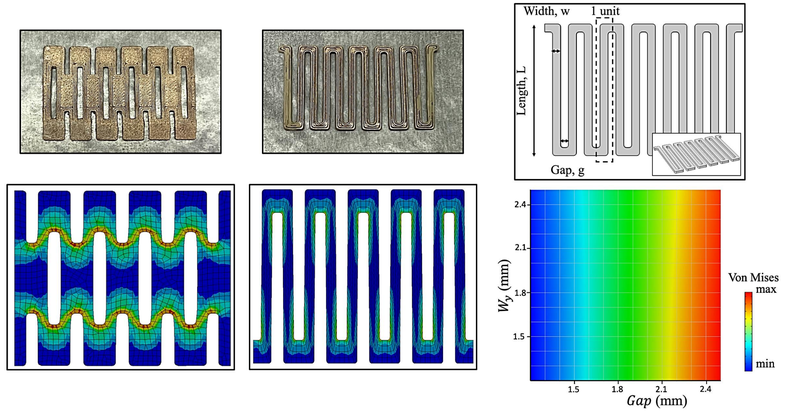
Visual description of the set up used to 3D print the kirigami conductors

- A FDM 3D printer is augmented to utilize a conductive polymer.
- For optimal results, the conductors are printed at 175°C.
- Kirigami conductors with varying cross-sections concluded which of the two should be further pursued.
- Numerous models made found the ideal design to be used for the conductors based on von Mises stress while two-dimensional.
- The stress was then analyzed with ANSYS during the three-dimensional deformation.
- Comparative studies of the deformation and resulting tensile properties determined if our hypothesis is correct.

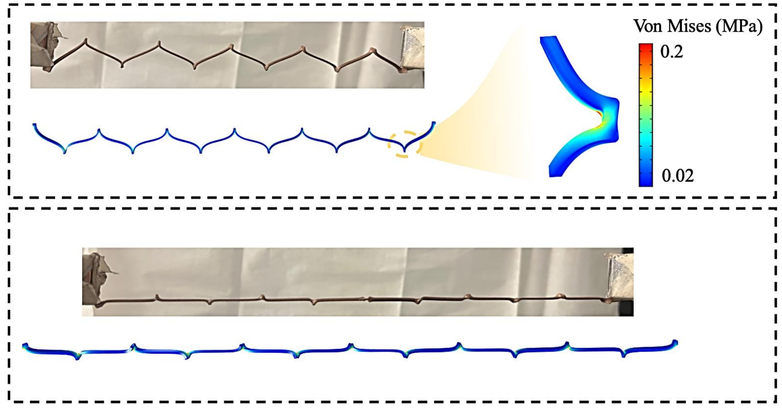
Results



Resulting stress-strain curves of perpendicular and parallel cross-sections.



Stress concentration of kirigami designs while undergoing small deformation.



Stress distribution of von Mises stress, during three-dimensional deformation.

Conclusion

- Utilizing a parallel pattern for the filament compared to a perpendicular pattern will result in eight times the elongation.
- Design of experiment, concluded that for optimal durability the parallel cross-section design would be implemented for the continuation of the research project.
- The hypothesis proved correct as stress distribution of the kirigami conductors while stretched confirmed maximum stress is at the location of deformation.

References

- Isobe, M. and Okumura, K. Initial rigid response and softening transition of highly stretchable kirigami sheet materials. *Sci. Rep.* **6**, 24758; doi: 10.1038/srep24758 (2016).

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