attached to the hand, limb, knee, throat, foot, wrist, fingers, toes, waist, neck and elbow.

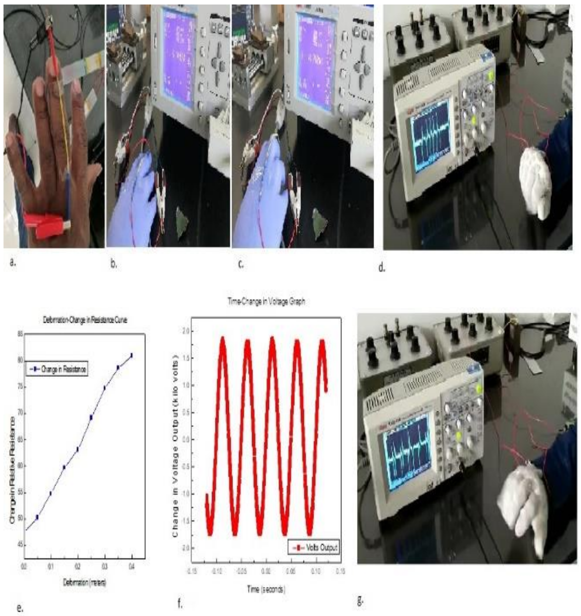

Fig 10. (a) Fabricated strain sensor successfully adhered to gloves and worn over the fingers *to* be monitored. *(b)* The time-change in the voltage output graph of the strain sensor when attached to the fingers. *(c)* The deformation-change in the resistance curve of the strain sensor when attached to the fingers.

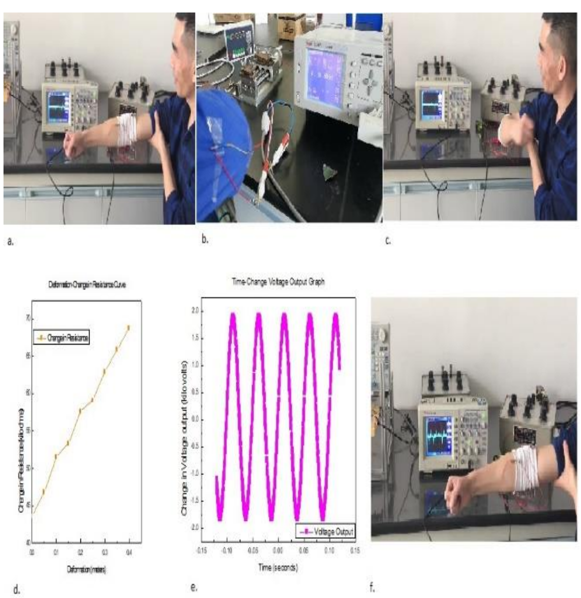

Fig 11. (a) Fabricated strain sensor successfully adhered to a bandage and a cloth and worn over the elbow to monitor the movement and motion of the elbow. (b) The deformation-change in the resistance curve of the strain sensor when attached to the elbow to monitor motion. (c) The time-change in voltage output graph of the strain sensor when attached to the elbow.

Conclusion

A novel of low-cost packaging technology for an ionic liquid-based strain sensor and a large strain sensing technique of using an aqueous sodium chloride solution encapsulated in an elastic natural rubber tube is introduced. The flexible aqueous sodium chloride/elastic natural rubber tube-based strain sensor showed high sensitivity at low strain can withstand large deformations and outstanding linearity at high strains. These unprecedented merits provide precise and reliable detections of subtle vital signals. Mechanical characterization and analysis of the fabricated flexible strain sensor has been conducted and the parabolic strain response is verified. Fig 4-5 clearly shows that the fabricated flexible strain sensor obeys the Hooke's law, the elastic natural rubber tube used in the fabrication of the flexible strain sensor is a Hookean material, the fabricated strain sensor is not a stiffer substance and very responsive to deformation because the fabricated strain sensor has a low ability to resist deformation, the stress-strain relationship is linear and the deformation is elastic in the case of the fabricated flexible strain sensor. Fig 6 show that the experiment conducted is repeatable, the fabricated flexible strain sensor is linear and accurate. The fabricated flexible strain sensor also has a gauge factor of 2.15 at an applied strain of 30%, which is around the theoretical path/standard gauge factor of strain sensors (that's 2). Fig 7-9 clearly show that the concentration of sodium chloride in the aqueous sodium chloride solution used as the sensing element of the fabricated flexible strain sensor, the inner diameter and length of the elastic natural rubber tube used in the fabrication of the flexible strain sensor has no bearing effect on the sensitivity of the flexible strain sensor to applied strain. Fig 10-11 clearly indicates that the fabricated flexible strain sensor can be easily attached to other materials/applications to monitor strain. This ionic liquid strain sensor (aqueous sodium chloride solution/elastic natural rubber tube) may be very useful in broad applications in electronic skin, biomedical implants, human movement monitors, and so on, due to its various advantages.

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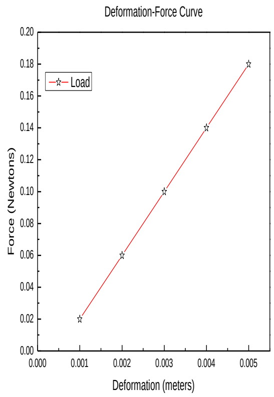
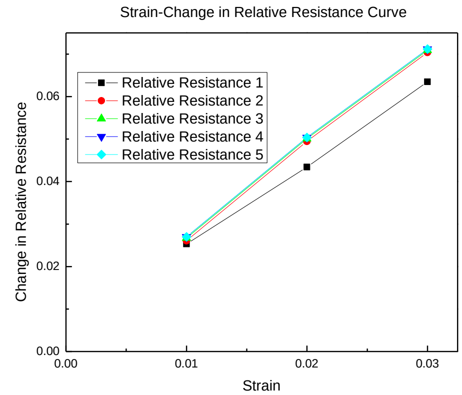
Authors

Sekyere Nana Gyamfi is a postgraduate student at the manufacturing and mechanical engineering department of Southwest University of Science and Technology, Mianyang-Sichuan, China. E-mail: minst2k@gmail.com

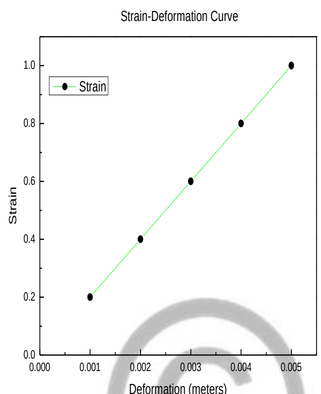
Dr. Yuan Weifeng is a professor, supervisor and a researcher at the manufacturing and mechanical engineering department of Southwest University of Science and Technology, Mianyang-Sichuan, China.


Deformation-Force Curve
Load
Force (Newtons)
Deformation (meters)

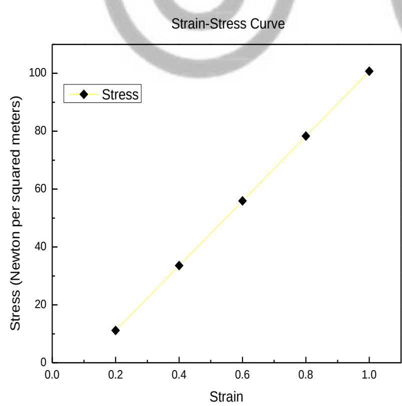
(a)


Strain-Change in Relative Resistance Curve
Relative Resistance 1
Relative Resistance 2
Relative Resistance 3
Relative Resistance 4
Relative Resistance 5
Change in Relative Resistance
Strain

(b)


Strain-Deformation Curve
Strain
Strain
Deformation (meters)

(c)


Strain-Stress Curve
Stress
Stress (Newton per squared meters)
Strain

(d)