# Flexible bending sensors using laser-induced graphene transferred onto PDMS

**(D)Yan Xuan, Satoko Honda, Kuniharu Takei**
**Department of Physics and Electronics, Osaka Metropolitan University**
**E-mail: se22923x@st.omu.ac.jp**

Bending sensors measure the bending radius of the curved object's surface through its change in electrical resistance. Common bending-sensitive materials include carbon-based materials, transition metal (silver, copper), and conductive polymers, which are fabricated on the surface of flexible substrate and changes its resistance upon bending. Bending sensors usually have the characteristics of light weight, low cost, robust and tolerance vibration. Due to the development of wearable devices and flexible electronics, the application fields of bending sensors are expanding, including medical treatment, human-computer interaction, physical activity measurement, etc.

In this work, we investigated the 3D structure of laser-induced graphene (LIG) transferred on PDMS and explored the electromechanics properties of LIG. LIG is patterned directly on polyimide film by $CO_2$ laser and transferred onto PDMS films. The surface morphology and cross-sectional view of the LIG printed on Polyimide film were shown on **Fig.1 (A)** and **(B)**. Due to the line-by-line scanning of the laser, the surface of the LIG presents a striped structure. From the side view, it is further found that there is a triangular prism-like structure, which is closely arranged line by line. When LIG was transferred from Polyimide to PDMS, the bottom structure of LIG was also revealed and observed. From **Fig.1 (C)**, it is observed that the surface of the transferred LIG also exhibits a stripe-like structure. From the side view of **Fig.1(D)**, the triangular prism structure is embedded in PDMS, and the surface is relatively flat with no obvious ups and downs. This special structure makes LIG sensitive to the bending radius. **Fig.2** shows the resistance change ratio of LIG on PDMS. In compression state, the resistance linearly decreases while it increases in tensile strain as a function of bending radius. This feature could identify the direction of curvature of the object.

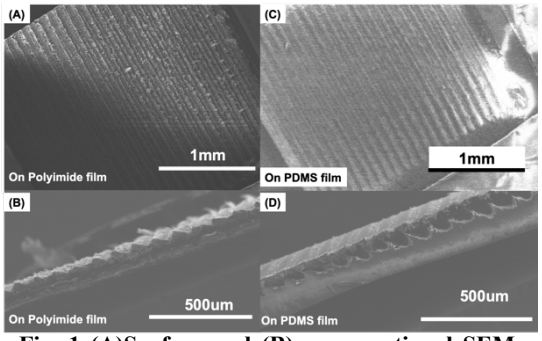


**Fig. 1 (A)Surface and (B) cross-sectional SEM images of LIG on polyimide film;(C) Surface and (D)cross-sectional SEM images of LIG on PDMS film**

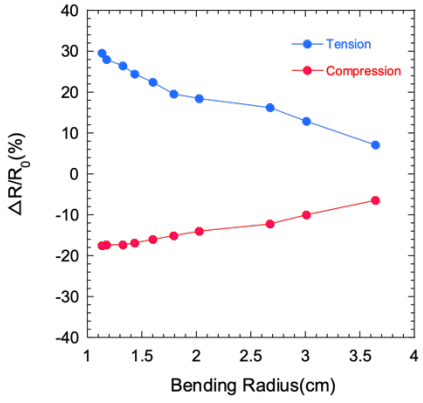


**Fig. 2 Resistance as a function of bending radius during tension and compression of LIG**

Through this special mechanism of LIG, we successfully demonstrated a bending sensor using LIG and PDMS.

***Acknowledgements:*** This work was supported by JSPS KAKENHI (JP18H05472, JP22H00594), JST AIP accelerated program (JPMJCR21U1), the TEPCO Memorial Foundation, and the Murata Science Foundation.