



Experimental Research on Temperature Characteristics of 2D Micro Scanner

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- **Introduction**
- **2D Micro Scanner**
- **Temperature Characteristics**
- **Conclusion**



○ 2D Micro Scanner

- Micro/nano-satellite with MEMS technology
- Space regional optical scanning and detection
- Affected by the space environment with temperature changes

○ Motivation

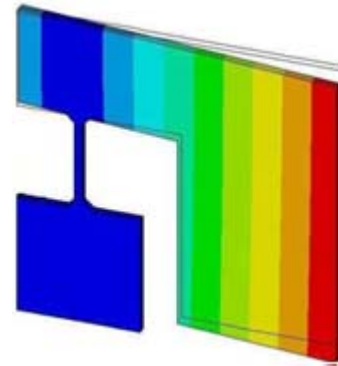
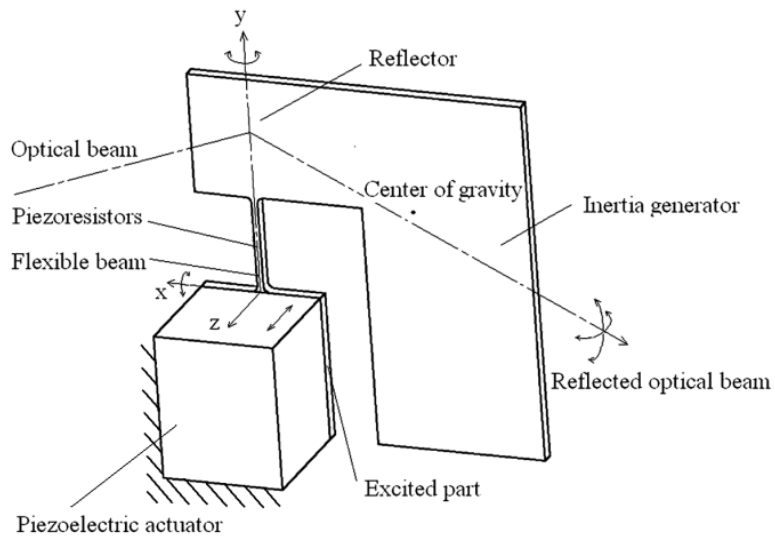
- Research the temperature characteristics of 2D Micro Scanner
- Test the space temperature adaptability
- Provide the experimental evidence for space application



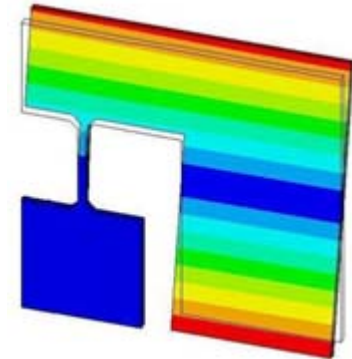
2D Micro Scanner

★ Structure and principle

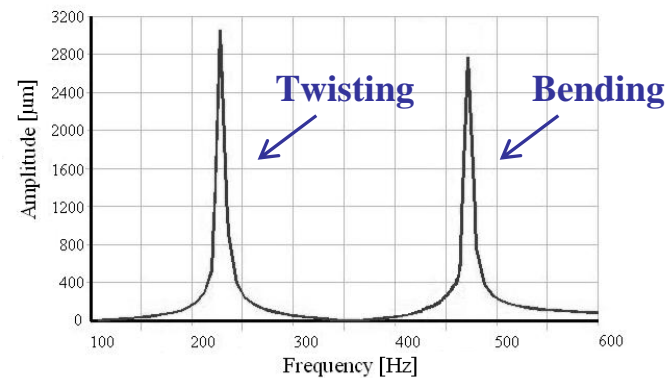
- Piezoelectric actuation
- Resonant scanning
- Piezoresistors sensing



Twisting by y-axis



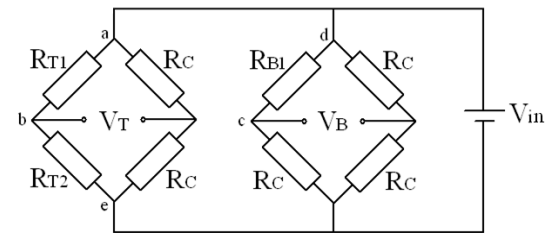
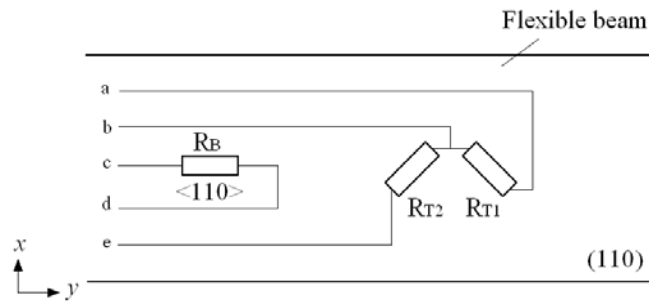
Bending by x-axis



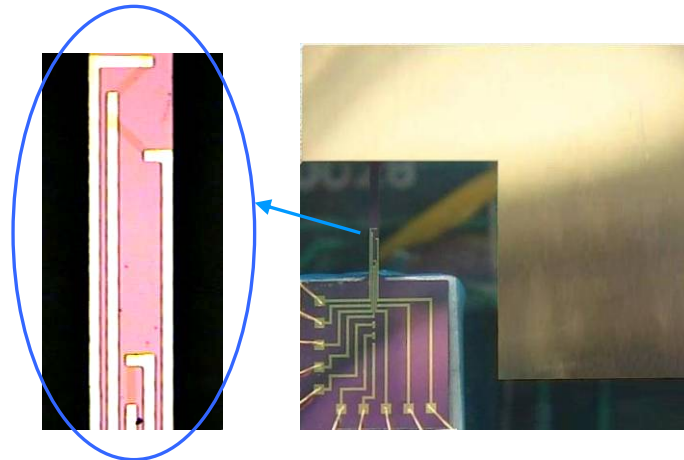
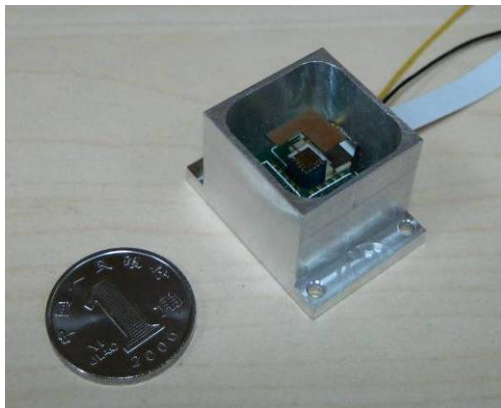


2D Micro Scanner

★ Piezoresistors



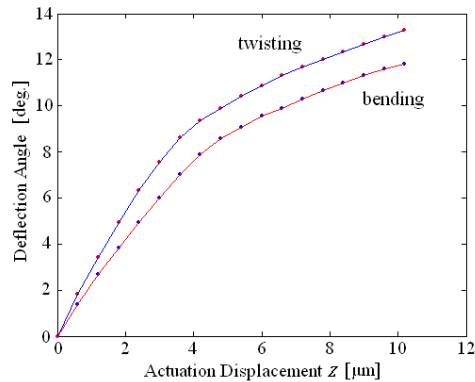
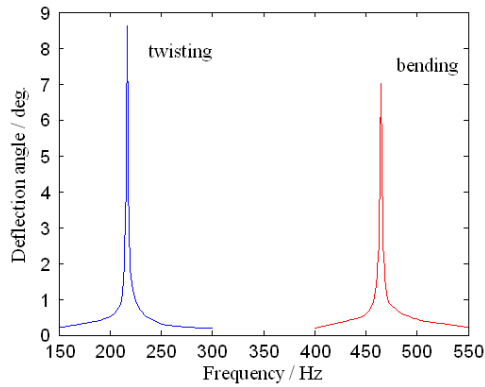
★ Prototype





★ Characteristics

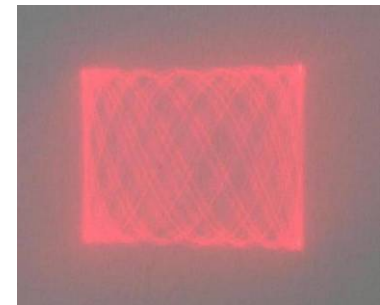
➤ Scanning



Twisting

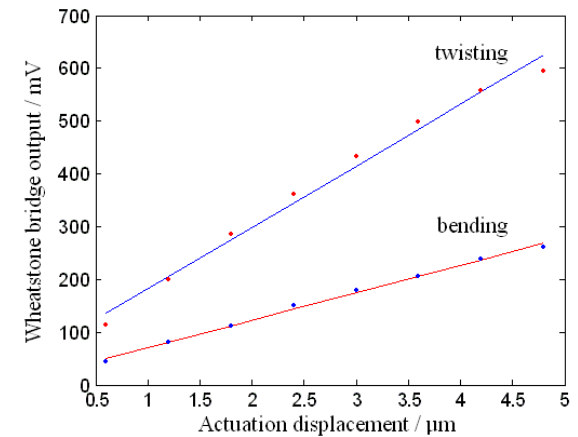


Bending



Coupled

➤ Piezoresistors

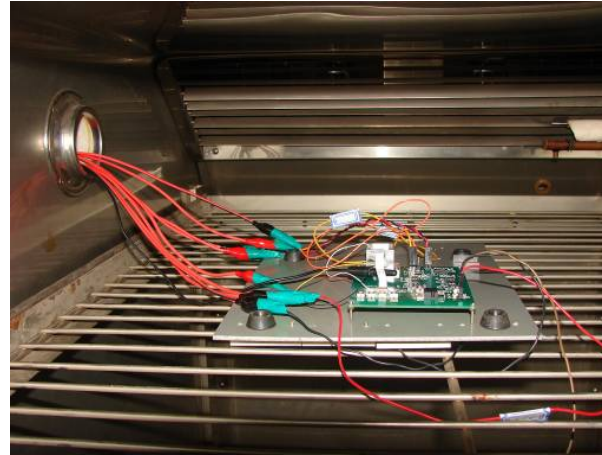




Temperature Characteristics

★ Experimental method

- Dry temperature chamber
- Range of -20°C to 80°C and interval of 5°C
- Measure the two resonant frequencies and two piezoresistive Wheatstone bridges characteristics

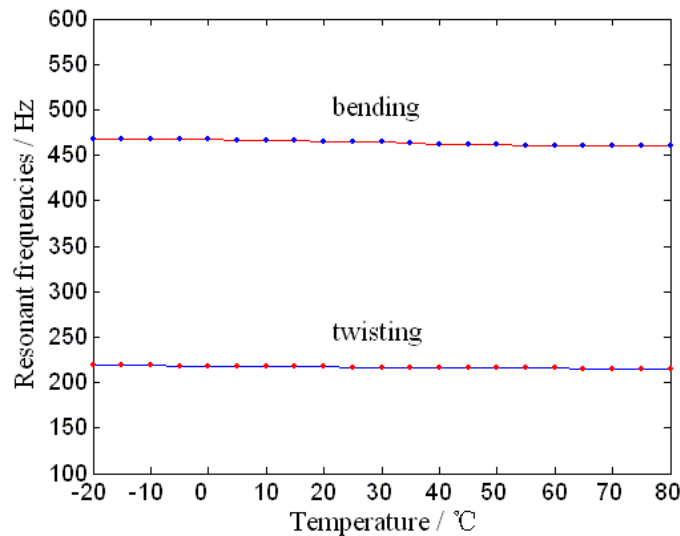




Temperature Characteristics

★ Resonant frequencies

- Two resonant frequencies slowly decrease with a rise of temperature
- Twisting mode: ranges from 219Hz to 215Hz
- Bending mode: ranges from 468Hz to 460Hz

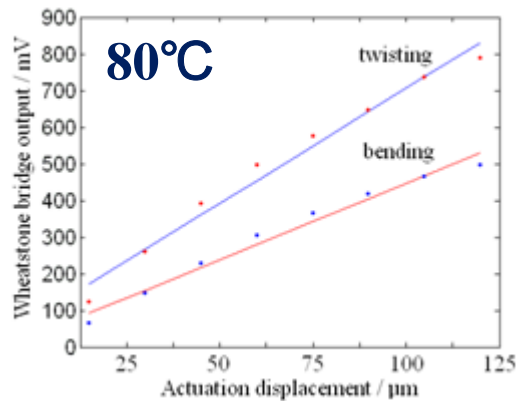
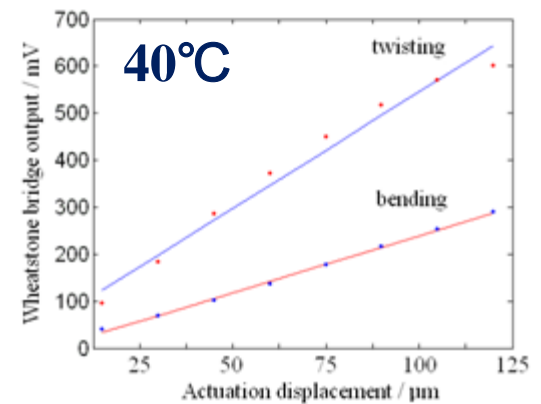
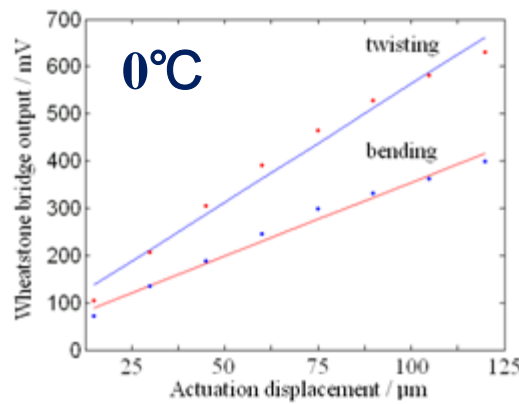
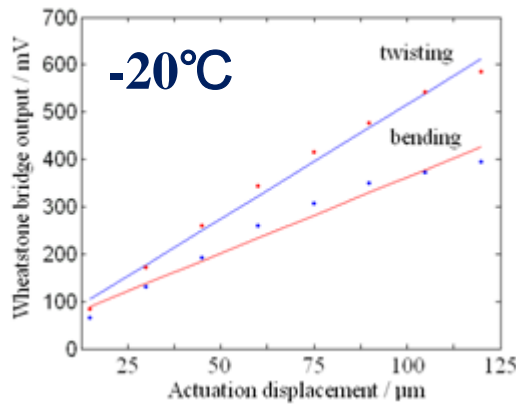


- The temperature change has little effect on the two resonant frequencies of the 2D micro scanner



Temperature Characteristics

★ Piezoresistors performances

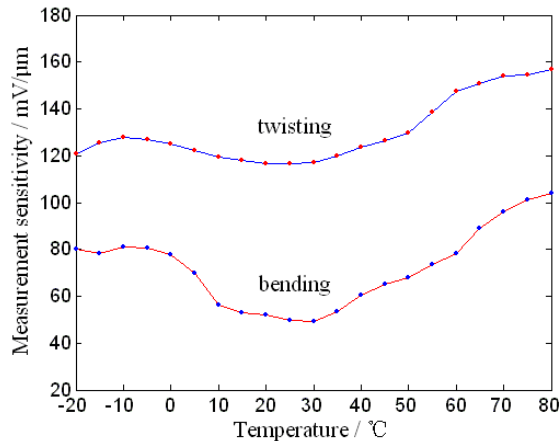


- In the temperature range, the piezoresistors have a good stress sensing performance. There are always linear relationships between Wheatstone bridge output and actuation displacement.

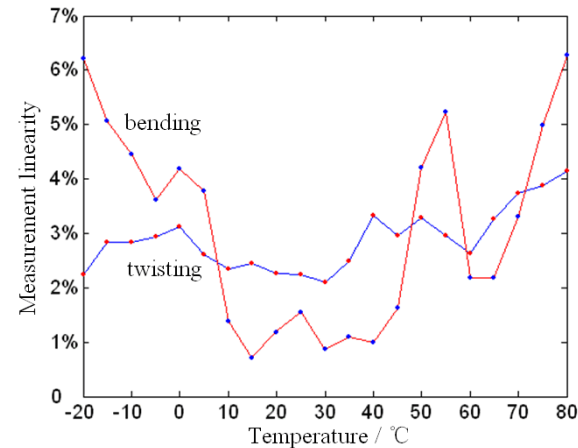


★ Piezoresistors performances

➤ Measurement sensitivities



➤ Measurement linearities



➤ Main reasons

- Temperature dependence of piezoresistive coefficient
- Temperature dependence of Young's modulus
- Thermal expansion of micro-structure
- Temperature dependence of damping coefficient



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Conclusion

- ★ **The space temperature adaptability and characteristics of the 2D micro scanner is tested in the temperature range of -20°C to 80°C .**
- ★ **In the range of 10°C to 30°C , the 2D micro scanner has two steady resonant frequencies, smooth piezoresistive measuring sensitivities and better linearities which are less than 2.5% and 1.6%, respectively.**
- ★ **The range of 10°C to 30°C is the optimal temperature range for space application.**



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Thank you !