Formation and Mechanics of High-Tesla Neutron Stars

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What is a Magnetar?

Definition:



Figure: Artistic depiction of a magnetar

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Definition:

neutron star



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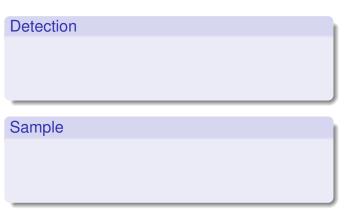
Definition:

- neutron star
- massive magnetic field (≥ 10¹³ G)



Figure: Artistic depiction of a magnetar

Distinctions



Distinctions

Detection

- 2-12s period X-Ray bursts
- large spin-down rates imply massive magnetic fields

Sample



Distinctions

Detection

- 2-12s period X-Ray bursts
- large spin-down rates imply massive magnetic fields

Sample

- Piezoelectric Suspension
- Indium-Tin Oxide coated PET plastic (0.01" thickness)

Bi-modal

Persistent Magnetars

Cross-species

Bi-modal

- Persistent Magnetars
- Transient Magnetars

Cross-species

Bi-modal

- Persistent Magnetars
- Transient Magnetars

Cross-species

Magnetar Pulsar

Bi-modal

- Persistent Magnetars
- Transient Magnetars

Cross-species

- Magnetar Pulsar
- Theoretically: neutron star switch between magnetar, pulsar, and magnetar pulsar



Materials

BaTiO3 nanoparticles - \$30/25g

Per Sample

0.04g BaTiO3 nanoparticles

Materials

- BaTiO3 nanoparticles \$30/25g
- Flexible Photopolymer \$90/1kg

Per Sample

- 0.04g BaTiO3 nanoparticles
- .2g Flexible Photopolymer

Materials

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- Flexible Photopolymer \$90/1kg
- Indium Tin Oxide PET \$5/(32 sq.in. sheet)

Per Sample

- 0.04g BaTiO3 nanoparticles
- .2g Flexible Photopolymer
- 1.5 sq.in. Indium Tin Oxide PET

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Per Sample

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- .2g Flexible Photopolymer
- 1.5 sq.in. Indium Tin Oxide PET
- Total Cost per sample: \$0.30

Standards

- 176-1987 IEEE Standard on Piezoelectricity (withdrawn)
- No other applicable standards were found

Control Test:

6 wt% Test:



11 wt% Test:



20 wt% Test:

Sources of Uncertainty

- Force measurement
- Unknown polymer structure
- Noisy Environment



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Further Study

Better understand the polymer

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- Better understand the polymer
- Explore other piezoelectric ceramic nanoparticles.

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- Better understand the polymer
- Explore other piezoelectric ceramic nanoparticles.
- Determine how to use suspension in 3D printing.

Resources

- Project Files: https://github.com/mflibby/FlexPiezo
- Samples Request: mackenzieflibby@gmail.com

References

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- Yang, Y., Pan, H., Xie, G., Jiang, Y., Chen, C., Su, Y., Tai, H. (2020). Flexible piezoelectric pressure sensor based on polydopamine-modified BaTiO3/PVDF composite film for human motion monitoring. Sensors and Actuators A: Physical, 301, 111789. doi: 10.1016/j.sna.2019.111789