A Multipole Magnetoactive Elastomer for Vibration-Driven Locomotion

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Introduction

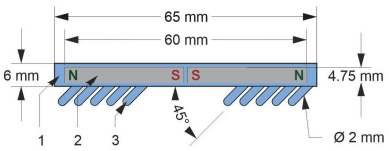
Intelligent materials such as magnetoactive elastomers (MAE) are a growing field of research, because their material properties can be reversibly adapted by an external magnetic field. This work investigates the bending deflection of a multipole MAE beam for the realization of vibration-driven locomotion systems.

Reserch material and MAE functional element

- Multipole MAE composition:
  - total magnetic filler 80-82 wt.%
  - 75 % magnetically hard powder NdFeB-alloy (characteristic size 100 μm)
  - 25 % magnetically soft powder Carbonyl iron powder (median diameter 0.5-12 μm)

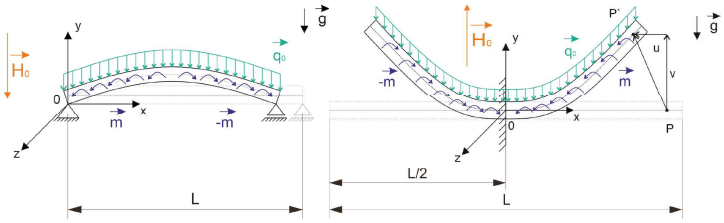
- Hard magnetic particles enable magnetization of the MAE beam
- Adjustment of the magnetic and mechanical properties:
  - active by an external magnetic field
  - passive by premagnetization

- MAE functional element for the realization of a movement by asymmetric friction
- Components of the MAE functional element:
  1-silicone casing
  2-multipole magnetized MAE beam
  3-silicone bristels sticking out at an angle

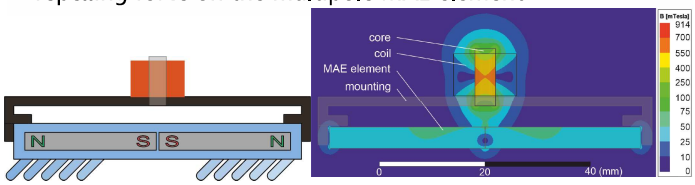


Bending of the MAE functional element

- Bending in an external homogeneous magnetic field
  - magnetic moment induced by an external homogeneous magnetic field

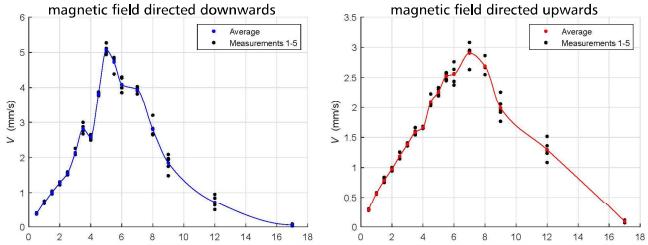


- Bending by an internal inhomogeneous magnetic field
  - Bending caused by the inhomogeneous magnetic field of a self-built coil
  - the multipole magnetization allows an attracting and repelling force on the multipole MAE element



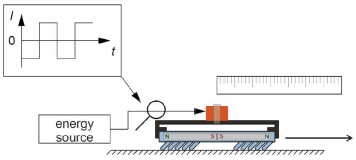
Movement of the locomotion system

- Design with external field source

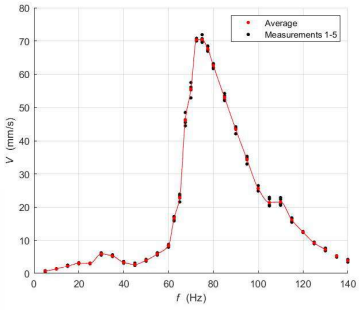


- Simple design, maximum speed of 5.1 mm/s, frequency range

- Design with integrated field source



- Fast locomotion, maximum speed of 70.4 mm/s, frequency range between 5 Hz – 140 Hz



Summary

The field-conntrolled bending can be used to generate a motion through the vibration of a multipole MAE. The bending can be caused by an external homogeneous magnetic field of a Helmholtz coil as well as by the inhomogeneous magnetic field of an integrated coil. The investigations show also promising potential in terms of operating conditions and possible applications

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