RARE EARTH AND CRITICAL MATERIALS DECEMBER 6, 2010 IN ARLINGTON, VA

Breakout Sessions:

Magnets

www.arpa-e.energy.gov

MAGNETICS: BACKGROUND

- Neodymium and Dysprosium, in high energy product permanent magnets, are of increased use in electric motors and generators.
- This workshop will address this materials shortage by:
  - Materials replacement at the component level, or
  - Magnet replacement at the system level .
- ARPA-E has already initiated two projects using spring-exchange coupling of traditional hard and soft magnetic phases.
- Looking for even newer / alternative approaches to reduced rare-earth content permanent magnets.

MAGNETICS: QUESTIONS

- Are there other non-rare earth content magnets which may exhibit high coercivity, particularly as a potential hard-phase in nanoscale composites?
- What new magnets might exhibit high coercivity with low rare-earth content?
- What are the technical barriers to the use of superconducting magnets in large-scale applications?
- What technology advances are required to use non-permanent magnet motors in transportation or heavy industrial applications?

MAGNETICS: METRICS

- Strawman Targets for Magnetics:
  - Motor (30kW) and/or Generators (4MW):

    (2020 APEEM Motor Targets with less than 2% mass as rare earth)
    - Less than $4.7/kW
    - Greater than 1.6 kW/kg and 5.7 kW/l
    - Less than 0.01 kg (rare earth) / kW

      (Less than 2% of mass as rare earth)
    - Greater than 98% energy conversion efficiency
    - Materials Alternatives or System level Approaches

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MAGNETICS: QUESTIONS

- Are there other non-rare earth content magnets which may exhibit high coercivity, particularly as a potential hard-phase in nanoscale composites?
  - Many others can be considered including Mg-based, improving AlNiCo, Iron-Chromium-Magnesium
- What new magnets might exhibit high coercivity with low rare-earth content?
  - Possibly NdFeB magnets with Low/No Dy content
  - Consider exchange-coupled magnets
  - Structures that can create shape anisotropy

MAGNETICS: QUESTIONS

- What are the technical barriers to the use of superconducting magnets in large-scale applications?
  - Current superconducting materials also include RE materials, may not be appropriate consideration for this activity
- What technology advances are required to use non-permanent magnet motors in transportation or heavy industrial applications?
  - Induction motors are currently used (e.g. Tesla) and can be considered as a "backup" technology to PM motors
  - Improved soft magnetic materials could benefit both induction and PM motors by eliminating rotor laminations
  - Alternative motor technologies

MAGNETICS: SUMMARY

- Need to consider multidisciplinary and system-level approaches
- Value in review of previous work in magnetic materials considering new methods and knowledge, as well as current international efforts
- New magnetic compounds may exist, but the search is very difficult
- Materials process to result in nanostructured composites
- Specifications exist for individual applications – these need to be considered for an FOA

MAGNETICS: METRICS

- Material Goals
  - RE Magnet: Dy-free or Dy-light
    - Hci 6,000 @200 C
    - Br 1.0 T @200 C
  - Soft Magnetic Material
    - 1.9 T, 0 resistance
  - Nanocomposite lean (25% RE content)
    - BHmax >70MgOe
    - Hci > 10 kOe

MAGNETICS: METRICS

- Material Goals
  - Non-RE Magnet
    - 20 MgOe
    - Tc >400 C
    - K > 10^7
- System Goals
  - Consider magnet performance vs. system performance