

PASREG 2010

Round Table: 31 JUL, 2010

Moderators: Dominic Lee & Herbert C. Freyhardt

Panel: Mitsuru Izumi, Mike Strasik, Frank Werfel, Tetiana Prikhna, Pavel Diko, Sang-Im Yoo, Archie Campbell

Invitation to the Panel Members:

We greatly appreciate that you are contributing to this year's PASREG. As you are well aware, the scope of PASAREG 2010 has been extended to reflect the evolving field. It will cover, besides processing and characterization, aspects of the broader spectrum of bulk high-temperature superconducting materials, including melt-cast Bi-HTS and bulk MgB₂, recent developments in the field, as well as innovative applications of bulk HTS.

We plan to organize for the first time a technical round table discussion (moderated by Dominic Lee & Herbert C. Freyhardt), the aim of which is to summarize state-of-the-art achievements in processing, characterization and applications, to identify bottlenecks to progress and efforts to overcome these, and to establish novel directions for future research.

We would like to ask you as an internationally respected colleague to participate as a member of this round table and to contribute and to stimulate further discussion with a critical beginning statement of about 3 min, which also asks pending questions and addresses critical issues, scientifically and beyond.

It is hoped that the summary of this round table might help to pave the way for a white paper. Please, respond at your earliest convenience whether you can participate and help to make the PASREG 2010 a success.

With many thanks and kind regards,

H.C.Freyhardt, M. Strasik & D. Cardwell

Intended structure of the discussion: (i) Application & visions (for novel applications) => (ii) What's needed, specifications etc. => (iii) Can this be accomplished, do we have roadblocks? (iv) What actions are required?

Introduction (H.C. Freyhardt)

- Bulk HTS. What are the (most) promising applications?
- Do we have the required bulk HTS materials available & what are the specifications?
- Do we understand the processing steps ... for REBCO bulks: Do we understand the growth + seeding (novel method: area seeding with thin films!); can we control both?
- Can we grow bulks with the required properties with a reproducible and robust process?
- Do we have sufficient long-term stability and are the mechanical properties good enough?
- Sufficient knowledge for characterization (comparison of properties: do we have/need standardized measuring procedures?)
- Do we have reliable processing of large quantities?
- Required actions

Introduction (Dominic Lee)

Some remarks during the discussion. The panel members and those from the audience, who contributed, were asked to mail their statements to HCF and Dominic Lee ...to incorporate them in a document.

- Mike Strasik: REBCO. Materials properties are good enough. Costs need to be around 50\$/lb. Enabling technologies are there, but costs need to be acceptable.
- Frank Werfel: Do not change materials, do not step from one material to the next ... apply the material. Parameters are excellent, sc's are good enough: but reliable charging/excitation is still needed. Economy: From an interdisciplinary team (materials, cryo, ...)
- Mitsuru Izumi: Combine science & technology. With regard to applications: What's the advantage of using bulk HTS? An honest comparison is needed.
- John Hull & Th. Coombs: Metrics! Reproducibility and predictability are essential for a robust process.
- Pavel Diko: Make HTS bulks cheaper through better optimization of microstructural properties.
- HCF: We are beyond demonstrators. To show the potential of bulk HTS, we have to get reliable prototype systems and devices.
- Tetiana Prikhna: We have good bulk MgB_2 , at 600 EURO/kg. Advantage: MgB_2 has a higher thermal conductivity & is of light weight.
- Frank Werfel: Sc's are not known by public, also their advantages are not well known.
- Kamel Salama agreed that flywheels might be the first application. Mike Strasik replied that Boeing management is still not convinced that one can bring down the costs. There is a need. How do we get the developers interested? Important is the cost/performance relation. For storage devices a number seems to be: 100 \$/kWh.

ADDITIONS & REPLIES

1. Road Map discussion (Frank Werfel)

I did collect some of our Podium positions during the PASREG'10. Here is the brief overview:

My conclusion: The scale of challenges we face with bulk superconducting applications is great and global. Public and private sector investment is still needed to cover a broad spectrum of potential applications utilizing our superior technique.

(i) What is needed (as we discussed in the session):

- improving the manufacturing process, batch processing, higher J_c , scaling
- Cooperation, domestic & international
- Progress in the application of the present bulk materials, commercial and defense
- What are the costs of a magnetic field of 1 T (bulks vs. coils)?
- Can we provide routinely field generators with bulks of 5 – 10 T at reasonably low costs?

(ii) We can improve energy efficiency due to superconductors in two ways:

- Reducing the amount of energy that we need to support our economy (our energy demand) through technological improvements. For example: Motors, generators, propulsion systems, Maglev and launching systems, magnetic bearings, all at reduced size and weight, as well higher efficiency and performance; and
- With our advanced sc technologies we can contribute inherently in changing our behavior to reduce the amount of energy that we waste... and our energy position may be an positive example for the society facing and targeting now the climate change and energy consumption.

We (Uta and myself) would like to thank the organizers of the PASREG'10 (Susan, Herbert , David & Michael).

2. Road Map Discussion (Pavel Diko)

Lower cost of REBCO bulk single-grain superconductors (BSS) may be achieved if we will increase pinning and eliminate weak links present in standard REBCO bulks. For example optimally irradiated YBCO BSS with diameter 20 mm can trap more 2 T [] what is much higher than in standard YBCO BSS without irradiation. It was demonstrated also at PASREG 10 that pinning can be improved by nanostructuring. Nanoparticles like 2411 (Cambridge, Houston) as well as chemical pinning centers which are promising steps in further pinning improvement for both YBCO ((TCS Houston, IEP Kosice, NCKU Tainan) and GdBCO (TUMST Tokyo) bulks Better understanding of crystal-chemical mechanisms controlling formation of chemical pinning centers to optimize microdoping and postgrowth thermochemical treatments can lead to effective nanostructuring providing pinning comparable with irradiation.

The second possibility is to eliminate weak links produced during oxygenation in the form of oxygenation cracks. It was already demonstrated on the small samples, that high temperature high pressure oxygenation can eliminate formation of these cracks and can lead to significant increasing of measured critical current density.

Better pinning and weak link elimination will reduce cost of the sample with the same properties as the size and consequently weight of the sample can be significantly reduced.

3. Road Map Discussion / Reply (Mitsuru Izumi)

What I would like to emphasize in respect to applied bulk HTS is that we should watch carefully any needs from cool earth and green concepts. At the same time, an international collaborative Outreach activity is required with a synchronization of materials engineering and application R&D.

During multiple discussions and mutual exchange of information it was agreed that the next PASREG will be organized by Ingann Chen / Taiwan.