Ceramic And Metallic Cellular Structures Wtih Interconnected Microchannels

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SUMMARY

UCLA researchers in the Department of Mechanical Engineering have developed cellular porous metallic and ceramic structures that can be used to increase the production and recovery of tritium for fusion power reactors or as a support for electrode materials.

BACKGROUND

Reticulated ceramics have generated interest in a wide range of applications, including bioceramics and tritium breeding beds for fusion power reactors. Another promising application is electrode support for fuel cells, capacitors, and batteries. In solid oxide fuel cells (SOFC) high porosity increases the device performance, but as the porosity increases the mechanical properties of the porous ceramics degrade. Thus, there is a need for reticulated ceramic-based electrodes with increased reliability and durability. In tritium breeding solid breeder blankets for fusion power reactors ceramic pebbles are being developed to perform transmutation reactions (n+Li → H3, He). However, these ceramic-based blankets have operational limitations due to poor thermal conductivity between the pebbles, pebble sintering during high temperature transients, and creep deformation that can lead to pebble fragmentation and pebbled-bed reconfiguration.

INNOVATION

UCLA researchers have developed reticulated metallic and ceramic bulk structures with an internal network of interconnected microchannels than can breed/filter tritium for fusion power reactors with high efficiency, and which could be used for electrode supports infuel cells, capacitors, and batteries. The cellular ceramic structures offer a 25 to 40% increase in tritium breeding material density (such as Li_2ZrO_3, Li_4SiO_4, Li_2TiO_4) in comparison to pebble-based beds. These structures have nearly double the thermal conductivity and an increased range of operating conditions for other chemical applications. The structures avoid high temperature sintering of pebbles and maintain their geometry. Moreover, the structures are free-standing bulk materials which have improved mechanical properties, resulting in the ability to withstand large temperature gradients (~50 °C/mm), and reduced creep (note: thermal expansion is not affected by much). The improved heat transfer coefficient between containment walls and ceramic reduces thermal gradients and thermal stress induced failures.

APPLICATIONS

- Chemical reactor
- Fusion reactors: producing tritium
- Electrode for fuel cells, supercapacitors, and other similar energy storage devices
- Catalyst for high temperature chemical reactions

ADVANTAGES

- Up to 40% increase in tritium breeding density
- Nearly double the thermal conductivity
- Increased range of operating conditions
- Improved mechanical properties
- Improved heat transfer coefficient

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	9,881,699	01/30/2018	2013-744

CONTACT

UCLA Technology Development Group
ncd@tdg.ucla.edu
tel: 310.794.0558.

INVENTORS

- Shaefer, Robert Shahram

OTHER INFORMATION

KEYWORDS

metallic, ceramic network structures, chemical reactors, tritium, cellular, sphere-packed pebble beds, porous structures, high temperature sintering

CATEGORIZED AS

- **Energy**
  - Other
  - Storage/Battery
- **Materials & Chemicals**
  - Ceramics
  - Storage

RELATED CASES

2013-744-0

UCLA Technology Development Group
10889 Wilshire Blvd., Suite 920,Los Angeles,CA 90095
tdg.ucla.edu
Tel: 310.794.0558 | Fax: 310.794.0638 | ncd@tdg.ucla.edu