Nano-crystal glass ceramic of high performance prepared from the residual waste from mineral resources

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Unit Brief Introduction

What Does KLIEBR Stand For?

KL  -  IE  -  BR

Key Laboratory  

Integrated Exploitation  

Bayan-Obo Resources
KLIEBR started at the beginning of the 90's as Metallurgy Research Institute, focusing on the simulation of metallurgy process with momentum, heat, mass transmissions.

3-dimensional calculation software was developed and successfully applied in tundish, mould, LF furnace and RH furnace.

2003,  Key Lab of Metallurgical Engineering ;
2004,  Key Lab of Advanced Metallic Material ;
2007,  Key Lab of Clean Combustion;

in 2007, KLIEBR became the key lab of Ministry of education.
Unit Brief Introduction

省部共建国家重点实验室培育基地

内蒙古自治区白云鄂博矿多金属资源综合利用

重点实验室

科学技术部

Aug 2010, Became Lab of Ministry of Science and Technology

Spring 2012, Exclusive Building came into service
KLIEBR’s Mission: Clean, High value-added, comprehensive utilization of BR

Problems:

- Niobiom, an advanced alloying element, has not been utilized
- Thorium, a new nuclear fuel, radioactive contamination, has not been utilized
- Tailings, BF slags and other solid waste take up a lot of valuable land resources
Products and Performance

The pilot plant of slag glass-ceramics
- Completion of the pilot plant: 2008
- Yield: 300 tons a year
- Method: melting and centrifugal casting
- Products: tube, plate, elbow, tee and other irregular parts

The pilot plant of foam glass-ceramics
- Completion of the pilot plant: 2011
- Capacity: 1000 cubic metres a year
- Method: sintering method
- Products: bearing brick, insulation board and anti-corrosion lining
Glass-ceramics tubes

The testing results from the China Building Materials Academy

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>g/cm³</td>
<td>3.21</td>
</tr>
<tr>
<td>Bending strength</td>
<td>MPa</td>
<td>192.25</td>
</tr>
<tr>
<td>Mohs hardness</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Abrasion loss</td>
<td>g/cm²</td>
<td>0.04</td>
</tr>
<tr>
<td>Impact toughness</td>
<td>kJ/m²</td>
<td>2.06</td>
</tr>
<tr>
<td>Acid-resistance</td>
<td>%</td>
<td>98.35</td>
</tr>
<tr>
<td>Alkali-resistant</td>
<td>%</td>
<td>97.78</td>
</tr>
</tbody>
</table>
Products and Performance

Glass-ceramics tubes
Products and Performance

Glass-ceramics compound pipe fitting
Products and Performance

Foam glass-ceramics bearing brick and insulation board
The application of slag glass-ceramics plate in metallurgical industry.

The service life of the nylon plate used previously was no more than 6 months. However, the service life of the slag glass-ceramics plate produced in our pilot plant was more than 3 years.

The application of slag glass-ceramics plate in a metallurgical plant of Baotou Steel (Group) Co..
The service life of the steel tube used previously was no more than 3 months. However, the service life of the slag glass-ceramics composite tube produced in our pilot plant was more than 2 years.
Application and Promotion

- The application of slag glass-ceramics composite tube in chemical industry.

The service life of the fiberglass tube used previously was no more than 2 months. However, the service life of the slag glass-ceramics composite tube produced in our pilot plant was more than 1 year.

The application of slag glass-ceramics composite tube in a chemical plant of Shenhua Group.
The application of slag glass-ceramics composite elbow in power industry.

The service life of the wear-resistant metal elbow used previously was no more than 5 months. However, the service life of the slag glass-ceramics composite elbow produced in our pilot plant was more than 2 years.
Innovative Points

- **Glass-ceramics with Excellent Structure and Performance**
  - abrasion resistant
  - corrosion resistant
  - high strength
  - nano-crystal

- **The Synergistic Mechanism of Trace and Valuable Elements**
  - glass phase separation and nucleation
  - refine grain
  - improve structure and performance

- **Good Formulas**
  - high-usage of solid waste
  - the wide range of compositions

- **Two Pilot Plants**
  - The slag glass-ceramics pilot plant
  - The foam glass-ceramics pilot plant
The Research Process, Achievement and Significance

Process

• **The First Stage: Basic Research (2000-2007)**
  ✓ The fund resource: Self-financing and funds from the school
  ✓ Research objectives: The development of glass ceramics formulation

• **The Second Stage: Pilot-Scale Study (2008-2013)**
  ✓ The fund resource: The municipal and provincial projects
  ✓ Research objectives: The development of glass ceramics formulation and the preparation process.

• **The Third Stage: Industrialization Precess(2014-)**
  ✓ The fund resource: The provincial and National (973) projects
  ✓ Research objectives: The development of the glass ceramics product, application and promotion
Achievement

- **Main Projects**
  - National Sci-Tech Support Plan: 2
  - Major Project of Chinese National Programs for Fundamental Research and Development (973 Program): 2
  - National Natural Science Foundation: 16
  - Inner Mongolia Science and Technology Innovation Guide Fundation: 5
  - Inner Mongolia R&D Project: 4
Achievement

Representative papers


The Research Process, Achievement and Significance

Achievement

Patents


[10] Double-tank type electric melting furnace, CN201310158180.

The Research Process, Achievement and Significance

Achievement

❖ Industry standard

JC/T 2283-2014 The slag glass-ceramics pipes.
The research and development of the slag glass-ceramics material prepared from the waste from mineral resources which is extremely important to the comprehensive utilization of solid waste.

Largely depletion of waste will achieve the goal of the secondary resource recycle.

The research and development of the slag glass-ceramics establishes a foundation for solving the stubborn problems, such as the land waste, water and environmental pollution, etc.
Thank you!