

**IC-MPPE**  
**Integrated Computational**  
**Materials Process and Product**  
**Engineering.**

Programme: COMET – Competence  
Centers for Excellent Technologies

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Zentrum

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Wedge splitting test; © Chair of Ceramics

## UNDERSTANDING THE FRACTURE BEHAVIOR OF REFRACTORY MATERIALS

SIMULATING THE FRACTURE BEHAVIOR OF REFRACTORY MATERIALS HELPS  
UNDERSTAND DAMAGE MECHANISMS AND EXTEND SERVICE LIFE

Refractory materials are essential for high-temperature processes used to manufacture nearly all materials in our daily lives. For example, they are required in the production of steel, glass, and cement. However, their production is associated with significant CO<sub>2</sub> emissions. Both industry and academia are therefore working to reduce the consumption of refractory materials.

One important approach is the simulation of how these materials behave under operating conditions, with the goal of improving their durability. A key factor in this context is thermomechanical stress, which arises from thermal expansion at high temperatures.

To perform such simulations, material models that accurately describe material behavior are required. In this project, the fracture behavior of coarse ceramic refractory materials was simulated using a “phase-field” model. This approach offers several advantages, including an excellent representation of the fracture process zone.

After successfully simulating laboratory fracture tests, the model was applied to industrial use cases.

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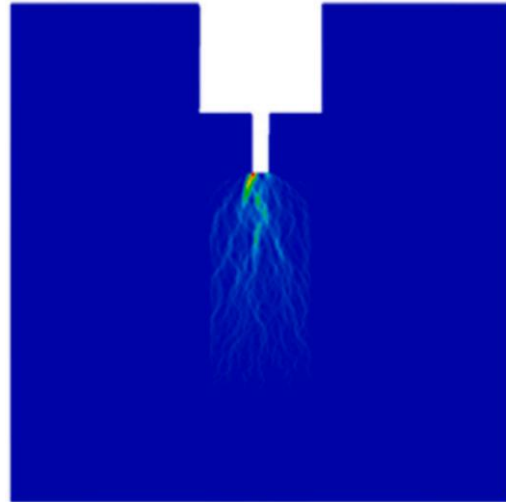
## SUCCESS STORY

### Impact and Benefits

Applying this model makes it possible to analyze and improve fracture behavior. The insights gained can also be incorporated into material development and the design of refractory linings. The developed model has been evaluated in collaboration with RHI Magnesita at the research stage, offering valuable insights and opening possibilities for future industrial use.

In 2020, the global market for refractory materials was estimated at around 50 million tons, with approximately 1.82 tons of CO<sub>2</sub> emitted per ton produced. This highlights the significant potential of material improvements and extended service life to make high-temperature processes more cost-efficient, lower in emissions, and more resource-efficient—particularly with regard to raw material consumption and waste generation.

Key goals include increasing the share of recycled materials and using raw materials with lower CO<sub>2</sub> intensity.



Simulated process zone in the wedge splitting test  
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### Project Coordination (Story)

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### Project Partners

- Montanuniversität Leoben, Austria
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- Materials Center Forschung GmbH, Austria

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