Beryllide Development at KIT in cooperation with Ulba Metallurgical Plant

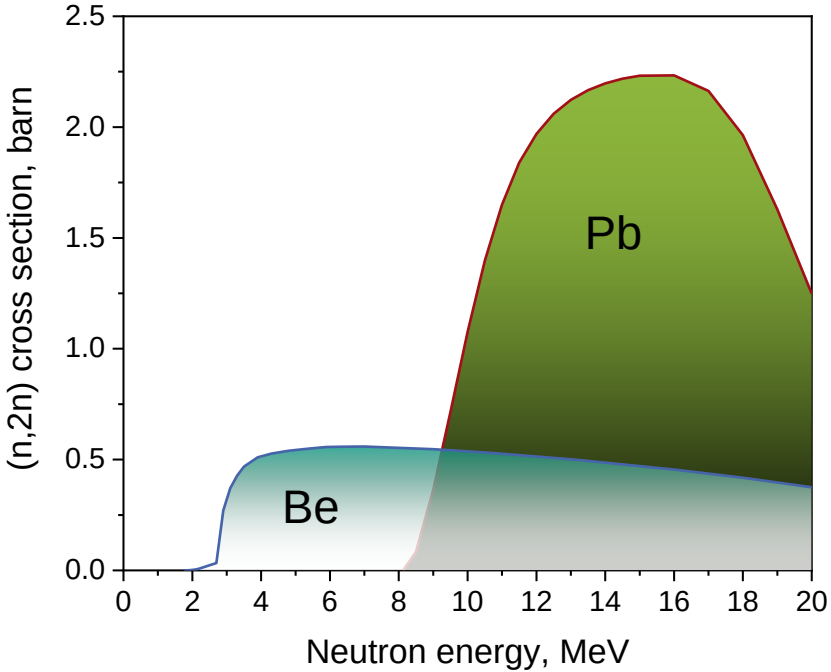
P. Vladimirov

Beryllium as neutron multiplier material

- **Beryllium** – best solid neutron multiplier, but …

ADVANTAGES:

- The most compact T-breeding blanket
- Avoids use of liquid metal
- Allows operation temperature above 400°C, thus avoiding irradiation embrittlement of structural materials



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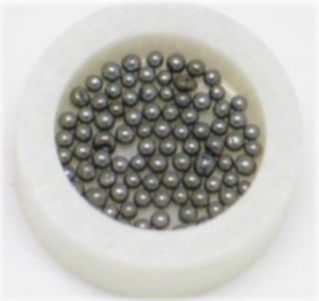
SHORTCOMINGS:

- High chemical reactivity with steam and air
- Relatively high volumetric swelling under neutron irradiation at temperatures above 650°C
- High tritium retention at low operational temperatures

NGK 1mm pebbles



As received

After interaction with steam @800°C

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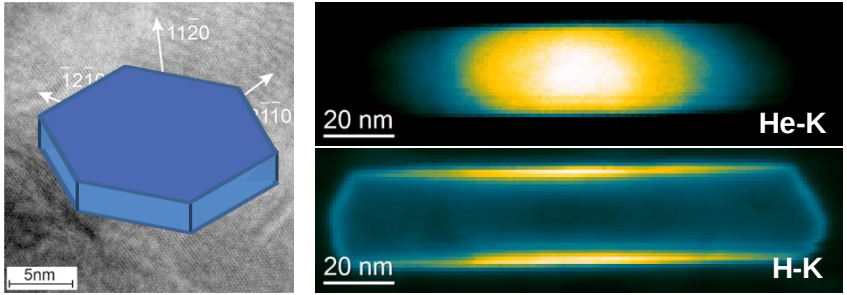

- Klimenkov, M.; Vladimirov, P.; Jäntsch, U.; Kuksenko, V.; Rolli, R.; Möslang, A.; Zimber, N. *Scientific reports* (2020) **10(1)**, 8042
- Klimenkov, M.; Vladimirov, P.; Hoffmann, J.; Zimber, N.; Möslang, A.; Kuksenko, V.; *Micron* (2019) **127**, 102754

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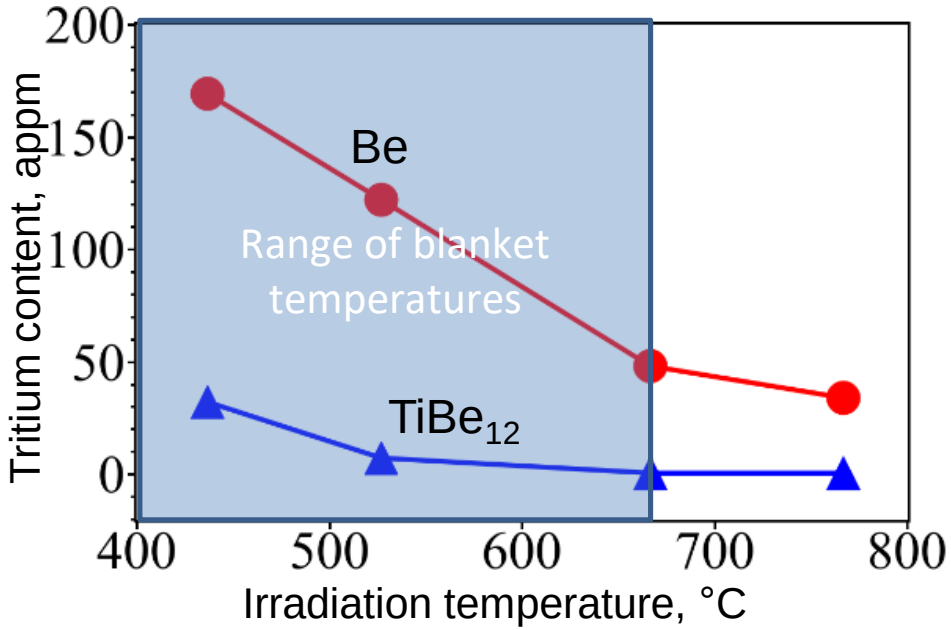
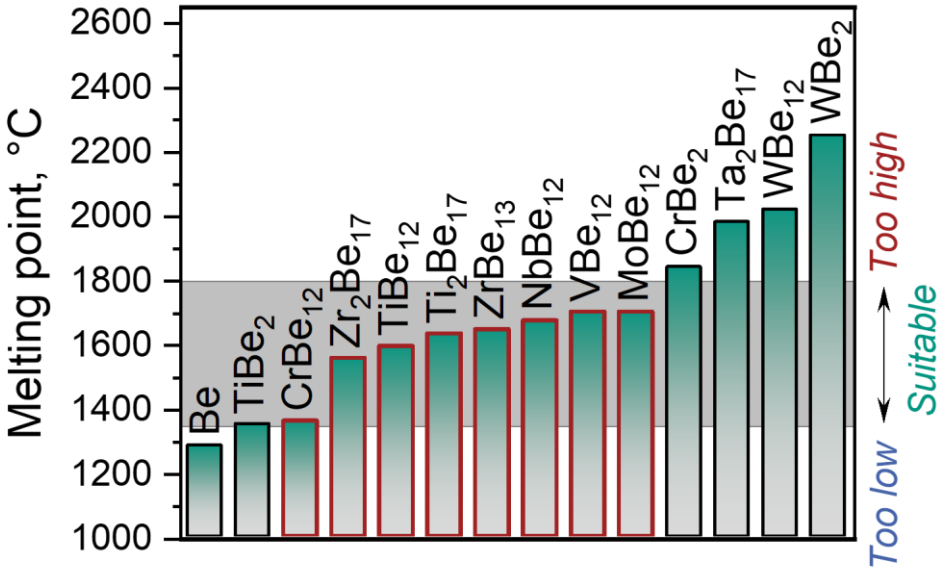


Beryllides as advanced neutron multipliers

ADVANTAGES:

- Higher melting temperature
- Lower chemical activity
- Higher irradiation resistance and lower swelling
- Significantly lower T-retention

Material preselection by melting point



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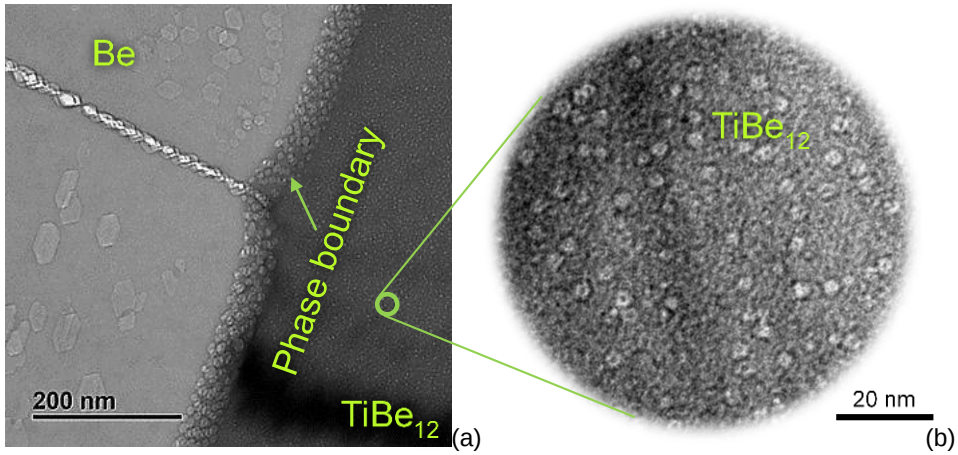
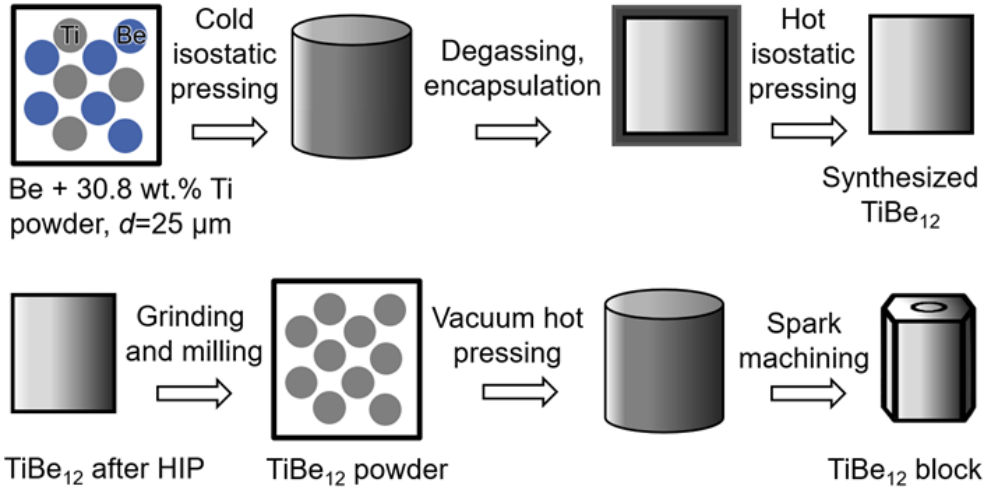
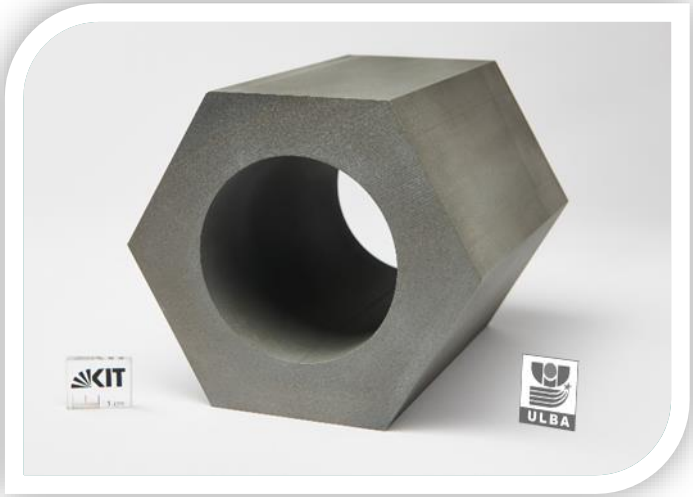


Beryllium and titanium beryllide phases irradiated in HIDOBE-02 at 530°C

Beryllide block production technology

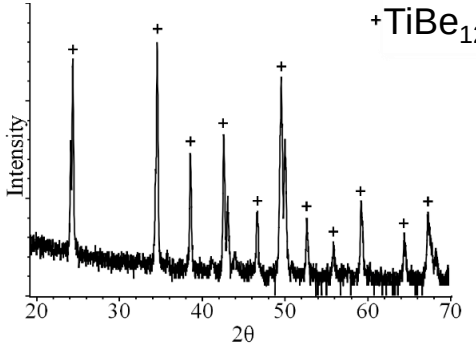




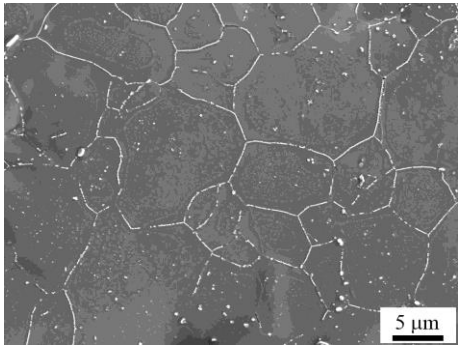
Fabrication of the first of a kind block from titanium beryllide with dimensions ∅144×150 mm² and density reaching 98.8% of the theoretical value. Such block was produced using common industrial equipment in service by the UMP, Kazakhstan.

Characterisation of $TiBe_{12}$ block

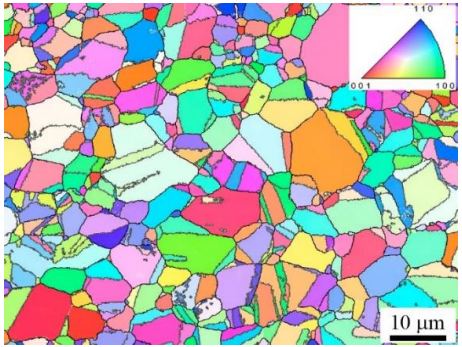
XRD



SEM

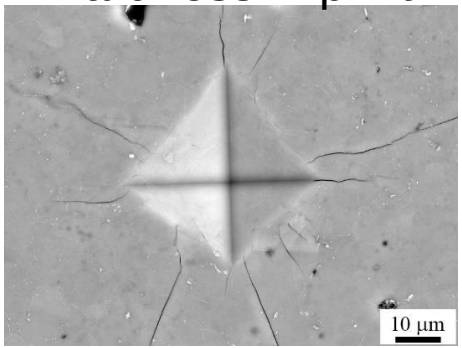


EBSD

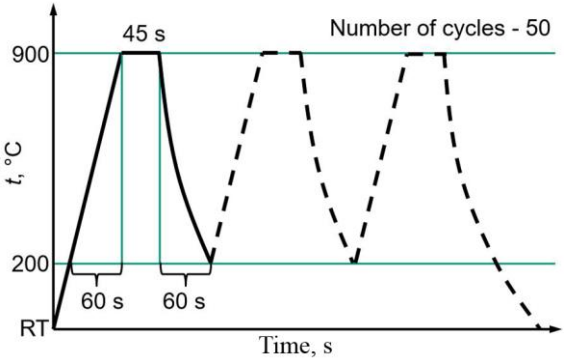


- $TiBe_{12}$ with traces of Be and BeO
- Very low Uranium content: <0.4 ppm
- Density: 98% of theoretical density
- Mean grain size: 8 µm
- Hardness: 1000 HV_1
- Fracture toughness: 2.4 $MPa \cdot m^{1/2}$

Hardness imprint

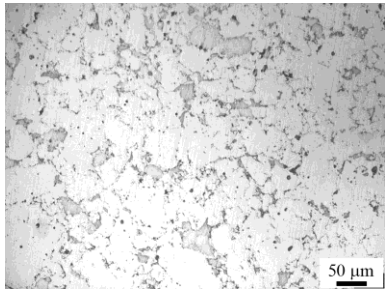


Thermocycling of $TiBe_{12}$



Induction heating of a $TiBe_{12}$ sample

$TiBe_{12}$ sample after thermocycling



No cracks or severe oxidation observed after thermo-cycling

Thank you for your attention!