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MASS PRODUCTION OF COMPONENTS FOR FUTURE FUSION POWER PLANTS VIA ONE- AND TWO COMPONENT PIM

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Motivation: Powder Injection Molding (PIM) is a time and cost effective near-net-shape forming process with advantages concerning shape complexity, material utilization and high final density. This work will investigate the new fully automatic 2Component-PIM (2C-PIM) tool to replicate parts of the KIT divertor design concept of modular He-cooled finger units such as the tungsten tile and tungsten alloy thimble in one step without brazing for the further DEMO power plant. 2C-PIM is a powerful process with high **economic efficiency** for **mass production**, **material development** as well as for **joining without additionally brazing** of even complex shaped parts.

The future fusion power reactor DEMO:

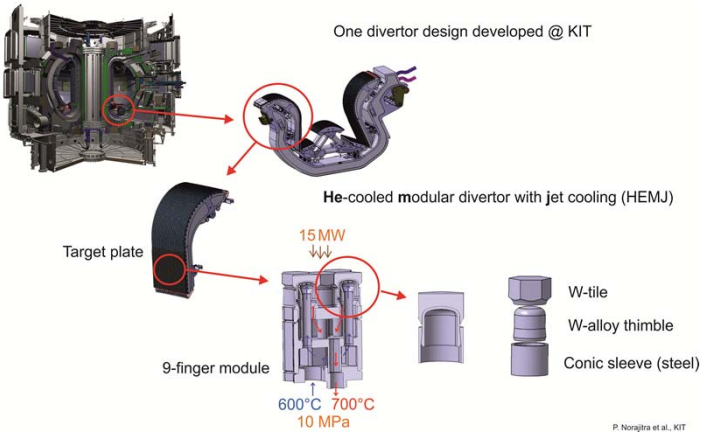

Fig. 1: Components of the HEMJ divertor.

The key steps in Powder Injection Molding for tungsten:

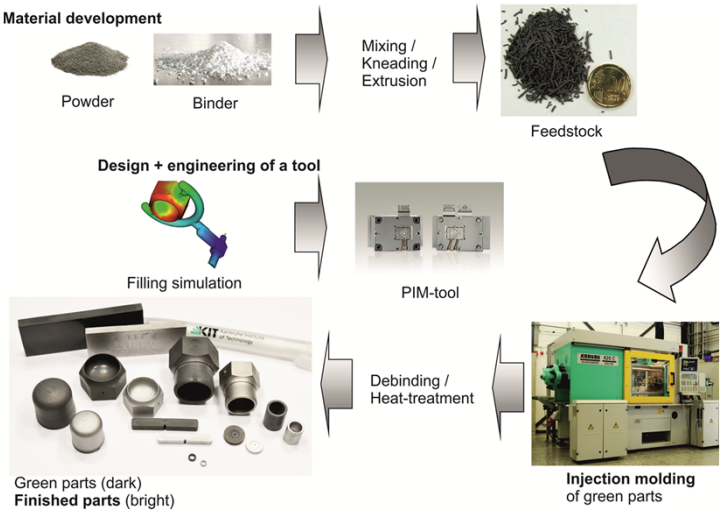

Fig. 2: The PIM process for W – developed @ KIT.

Injection molding with the new fully automatic 2C-PIM tool: Step I: molding of the W-alloy thimble (W-2La_2O_3 respectively W-2Y_2O_3) and automatic moving of the tool around 180 °. Step II: molding of the W tile on top of the thimble (see Fig 3).

The heat-treatment process: follows after debinding of the green parts. First pre-sintering (1800 °C, two hours, dry hydrogen atmosphere) to reach a state with only closed porosity. After that the samples were compacted by HIP-cycle (2000 °C, two hours, 200 MPa, argon atmosphere).

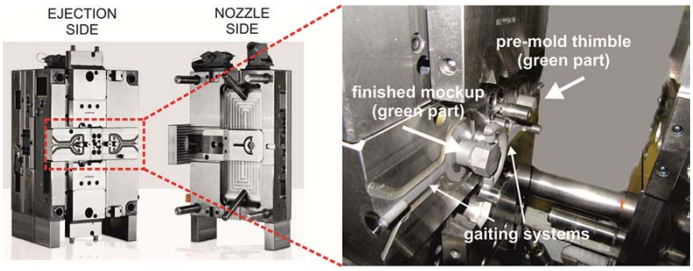

Fig. 3: Production of green parts with the new fully automatic 2C-PIM tool.

The material connection: of the 2C-PIM combinations W + W-2La_2O_3 (Fig. 4, middle) and W + W-2Y_2O_3 (Fig. 4, right) are successful. No cracks or gaps in the seam of the joining zone between the W tile and the W-alloy thimble are visible. As comparison, the resulting microstructure of the one-component tungsten PIM mockup is shown in Fig. 4, left.

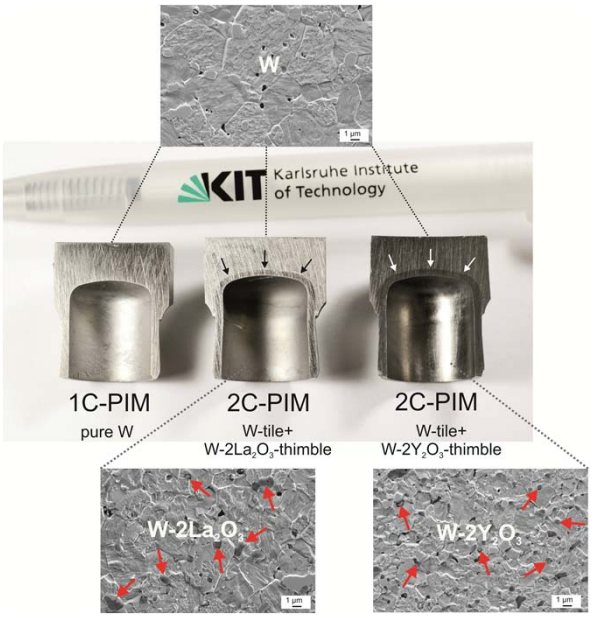

Fig. 4: Analyses of the joining zone quality between tile and thimble.

Tasks for future: One main key advantage of PIM is the fast production of new create materials and material compositions. The objectives of the future work will be the development and optimization of the properties of materials produced via PIM. All activities are in terms of the correlation of the PIM process chain process parameters and the obtained material properties. All investigations are in close cooperation with experts for characterization via HHF testing, material development and design teams.

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