

# Forming of thermoplastic ceramic tapes

Dipl.-Ing. Anne Mannschatz, Dr. Axel Müller-Köhn,  
Dr. Tassilo Moritz

Across industries, demand for highly stressed components for high-performance electronics and mobility electrification is growing. Functionalized and temperature-resistant components, such as circuit carriers or housings, are becoming increasingly important.

While ceramic components are particularly suitable for such applications, producing thin-walled ceramic parts by pressing and green machining is associated with high material losses. The use of multilayer technology to stack and laminate tapes can be an alternative, but its assembly process is elaborate and thus also means poor material utilization.

## Hydroforming

Together with Fraunhofer IWU, Fraunhofer IKTS has developed a new process to produce three-dimensionally shaped thin-walled ceramic components. It utilizes the temperature-dependent reversible softening and solidification of thermoplastics to save up to 80 % of material in the forming process. The ceramic powder is mixed with a thermoplastic binder system and processed into continuous tapes via extrusion (Fig. 1).

The flexible green tape is then placed in a heated mold and subjected to pressure – a step called hydroforming (Fig. 2). Nitrogen is used as a medium to press the tape against the mold cavity. After cooling, the tape is demolded. The binder is removed in a debinding process, and the ceramic part is finalized by sintering.

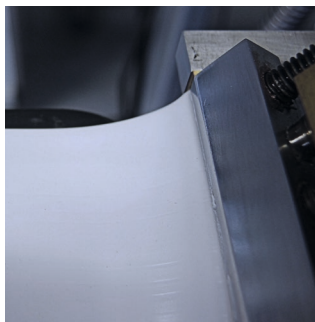


Fig. 1: Extrusion of thermoplastic ceramic green tape.



Fig. 2: Formed ceramic component.

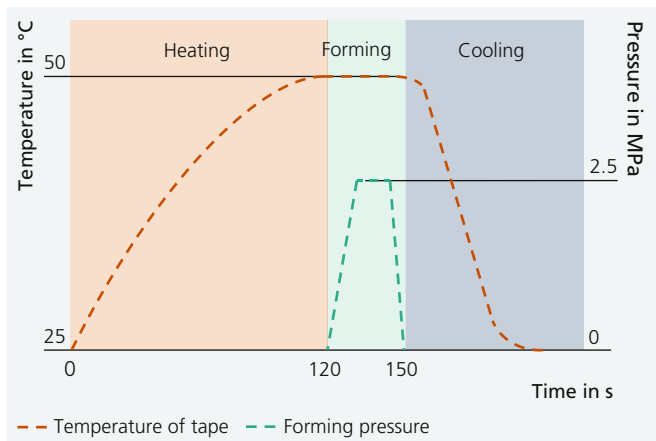


Fig. 3: Process scheme of hydroforming.

In the process, the thermomechanical behavior of the binder and the solid content determine how formable the tape will be. These values must be selected to achieve a high material elongation at the processing temperature without creating micro-defects. With precise temperature control, it has been possible to produce defect-free components (Fig. 3). The thermoplastic behavior of the ceramic green tapes also allows the application of other forming processes, such as thermoforming of plastics.

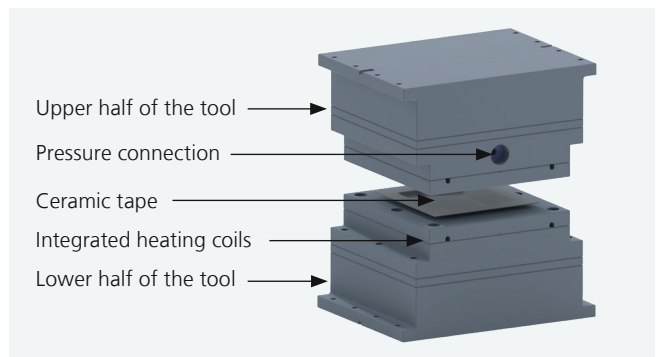


Fig. 4: Construction of the mold.

## Advantages of the process

- Production of thin-walled 3D-shaped ceramic components
- Integration of structural details in the forming process
- Reduction of material loss by 80 % compared with machining

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