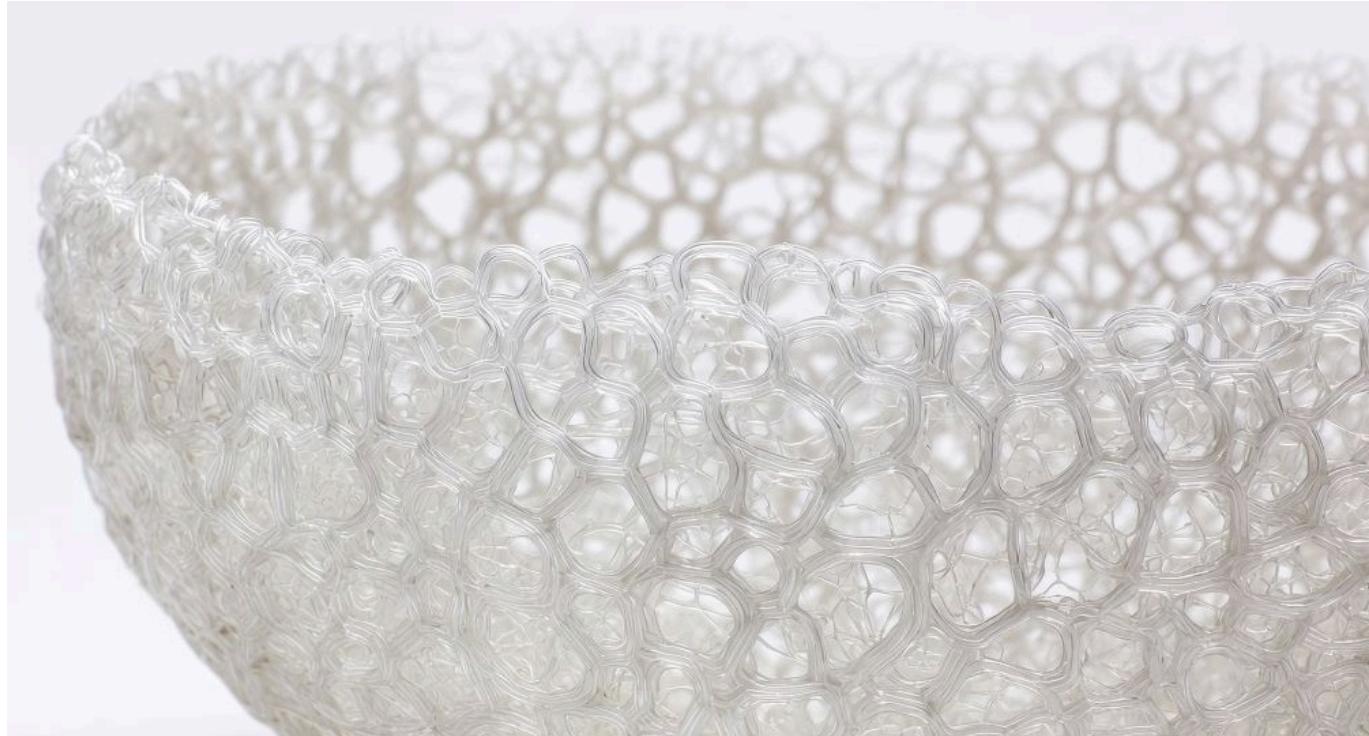


TECH OFFER

Stereolithography 3D-printing of Transparent Spinel Ceramics



KEY INFORMATION

TECHNOLOGY CATEGORY:

Materials - Ceramics & Glass

Manufacturing - Additive Manufacturing

TECHNOLOGY READINESS LEVEL (TRL): **TRL4**

COUNTRY: **SINGAPORE**

ID NUMBER: **TO175383**

OVERVIEW

There is a growing global demand for complex-shaped transparent ceramics such as spinel in specialised lenses, optoelectronics, electronic, semiconductor and biomedical applications. However, large-scale commercial production of ceramics parts of high transparency and complex geometries has not been fully established. At present, most transparent ceramics are commercially fabricated in simple geometries using conventional methods such as injection molding or hot-pressing. 3D-printing techniques such as direct ink-writing, digital light processing and stereolithography has enabled the fabrication of ceramic parts of higher complexities, but the optical transparency of such ceramic parts remains limited. As demand rises for precision engineering, stereolithography continues to evolve as a key pathway for transparent structural components, supported by growing industry interest in 3D printed ceramic innovations for optical-grade applications.

This technology is among the first to provide high-transparency 3D printed ceramic spinel ceramics with highly complex design. It integrates proprietary spinel ceramic paste, 3D printing process, and specialised heat treatment process. The resulting 3D printed ceramic possesses a high relative density, exceptional mechanical strength, good optical transparency and wide design flexibility.

Together, these advantages position the material as a strong alternative to current options such as 3D-printed silica glass, yttrium aluminum garnet (YAG), and sapphire. Moreover, compared to conventional manufacturing methods, 3D-printed spinel ceramics significantly reduce material waste while shortening the prototyping to production timeline. This appeals to both industry application and sustainability, and reinforces the unique value of 3D printed ceramic solutions for next-generation transparent components.

This technology supports a wide range of design complexities, resolutions, and application needs. The technology owner is currently looking for more industry collaborators that are interested in exploring and pushing the boundaries for 3D-printed transparent ceramics. They are able to offer flexible co-development modes for specific use cases for partners with or without existing in-house 3D printing capabilities.

TECHNOLOGY FEATURES & SPECIFICATIONS

This technology consists of the entire production process for producing 3D-printed transparent spinel ceramics. This includes:

- Expertise and know-how in 3D print paste formulation
- 3D print process parameters
- Post printing heat treatment process

Through our production process and expertise, the 3D-printed spinel products would have the following properties:

- >80% Transmittance at $\lambda = 500\text{-}700\text{ nm}$
- Hardness = 11.0 to 13.5 GPa
- Printing resolution = $\sim 200\text{ }\mu\text{m}$
- Product size = 4cm^2 to 35cm^2
- High complexity design

POTENTIAL APPLICATIONS

Some potential applications can be (but not limited to):

- Semiconductor industry e.g. equipments requiring transparency in harsh plasma or high-temperature environments
- Defense industry e.g. shrapnel-resistant transparent surfaces
- Medical industry e.g. surgical jigs and guides
- Dental industry e.g. transparent or translucent dental brackets
- Optical industry e.g. specialised lenses
- Other industries: applications requiring transparent & strong parts with intricate designs, applications requiring photocatalyst support, fashion

UNIQUE VALUE PROPOSITION

This technology is one of the first to enable the production of high-transparency 3D-printed spinel ceramics:

- High relative density, mechanical strength and optical transparency compared to other readily available 3D print ceramic technology.

- Compared to conventional manufacturing methods, 3D-printed transparent ceramics have the potential for rapid-prototyping, intricate and wide design flexibility, while improving in production sustainability and minimizing wastage.