ATARU™
NANODIMENSION

ATARU Black Resin: Validated Performance for High-Detail Additive Injection Tooling

An SKZ Feasibility Study Confirms ATARU as a Game-Changer for Short-Run Tooling

A comprehensive feasibility study conducted by SKZ for Nano Dimension GmbH successfully validated ATARU Black photopolymer resin as a highly suitable material for additively manufactured (AM) injection mold inserts. Utilizing Digital Light Processing (DLP) printer UnionTech PI200, the study demonstrated that ATARU resin offers exceptional detail replication, reliable dimensional accuracy, and, most critically, achieves outstanding service life when processing common, high-demand engineering thermoplastics.

The test inserts were evaluated using the stringent **"Stonehenge" benchmark mold**, developed by SKZ specifically to test the durability of resin-based AM inserts under real-world injection molding conditions. The results confirm that ATARU is ideally positioned for manufacturers seeking cost-effective, rapid tooling for short production runs of high-quality components.

"Its exceptional combination of mechanical strength, stiffness, and thermal stability—properties critical for withstanding the demanding conditions of the molding process".

Key Result 1: Precision and Manufacturability

1.Materials, Manufacturing and Post-Processing Procedures

The manufacturing process adhered to standard resin-based AM steps, including DLP manufacturing, cleaning, post-curing, and final machining.

1.1. Materials

The ATARU resin family has outstanding materials properties, especially remarkably high thermo-mechanical stability. With a Young's Modulus of 5.7 GPa and a tensile strength of 69 MPa, the material offers the rigidity and structural integrity necessary to maintain precise mold geometry under high clamping forces and injection pressures. Its strain at break of 1.8% indicates a brittle yet stable behavior, minimizing deformation and ensuring dimensional accuracy over repeated cycles. Most importantly, the resin's high thermal performance, characterized by a glass transition temperature (Tg), HDT/A, and HDT/B all exceeding 300°C, ensures that the mold can tolerate the elevated temperatures of molten thermoplastics without warping or softening. Even its HDT/C of 133°C provides resilience under less constrained conditions. Together, these properties enable the production of detailed, durable, and heat-resistant molds that bridge the gap between prototyping and low-to medium volume production in injection molding applications.

1.2 Additive Manufacturing and Dimensional Accuracy

To achieve a precise and smooth parting plane, the mold halves were printed in a **flat horizontal orientation**, despite common recommendations to print parts at an angle to reduce peel forces. **UnionTech PI200 printer** key process parameters, determined independently by SKZ.

1.3 Additive Manufacturing and Dimensional Accuracy

Post-printing cleaning involved multiple steps using Nano Dimension Resin Cleaner, followed by drying with compressed air. UV post-curing was conducted for 30 minutes on both sides (total 60 minutes). Then thermal treatment followed at 200°C for 2 hours.

Post treatment showed:

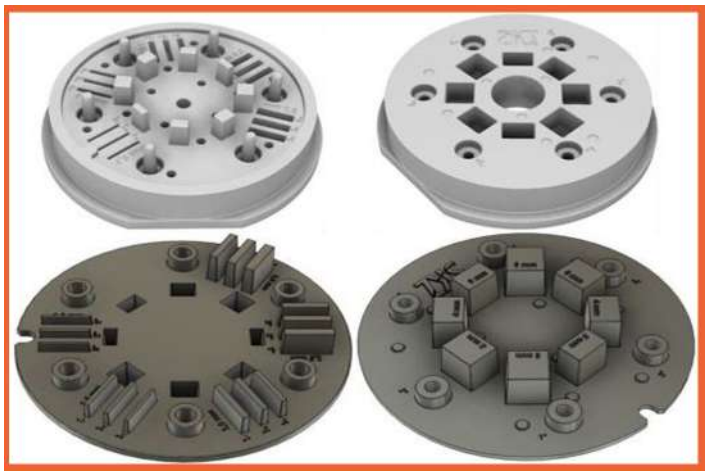
- **Very good dimensional accuracy**: in the X and Y directions (deviations of approximately ±50 µm).
- **Machinability:** The fitted tool inserts showed sufficient elongation at break to be tightly sealed without breaking. Inserts were successfully machined on a lathe to remove support remnants, adjust the outer diameter, and achieve the exact fit required for the master mold.
- **Detail Replication:** In successful trials (like ABS), all design features, including **lettering, through-holes, and cavities, were fully replicated.**

2. The "Stonehenge" Benchmark Tool Design

To rigorously evaluate the durability of the ATARU resin inserts, SKZ utilized the proprietary
“Stonehenge” benchmark mold. This test mold incorporates complex features specifically known to be challenging and prone to failure in additive mold making.

The geometry includes several challenging design features:

• **Cylindrical Pins and Blocks:** These structures represent the shrink-fit behavior of the molded part onto the core insert. They are designed with varying draft angles (1°, 2°, and 3°) to generate different demolding forces.
• **Ribs:** Ribs are featured in three variations, differing in draft angles (1°, 2°, and 3°) and wall thickness (from 1 mm to 3 mm), further simulating various demolding force scenarios.
The service life of the insert is directly indicated by the number of parts produced before material damage or breakouts occur.



“Stonehenge” *benchmark tool*
Test mold developed at SKZ for assessing the service life of
additively manufactured resin-based injection mold inserts.
The tool contains several geometric features that are considered
challenging and prone to failure in additive mold making

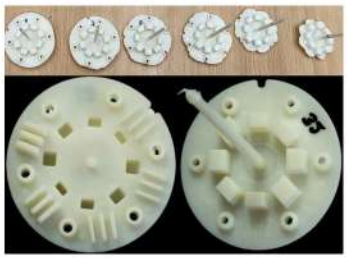
3.Durability Testing and Performance Assessment

Cleaned and post-processed Ataru mold halves.

The testing regimen involved fitting the AM inserts into a Meusburger FW quick-change master mold and executing injection molding trials until mold failure was reached, allowing for the determination of service life and failure causes. The tests monitored the mold insert surface temperature using a thermal imaging camera (Micro-Epsilon thermoIMAGER TIM 400) to ensure precise temperature control between cycles.

Key Result 2: Exceptional Service Life with Weakly Polar

The ATARU tool inserts demonstrated maximum durability and high service lives when processing **weakly polar plastics** with moderate shrinkage behavior. In these successful runs performed with Wittmann Ecopower 110 injection molding machine, the tests were terminated due to time constraints, confirming the tools' robust capacity to run far beyond minimum short-run requirements.

Thermoplastic Material	Service Life Achieved	Key Performance Highlights	Part
ABS (Acrylonitrile Butadiene Styrene)/ Terluran GP35	+110 Shots	Projected for 200+ shots. Test was terminated due to time constraints, with minimal damage observed (a small material breakout and a crack in the nozzle area). Process parameters used closely resembled those for a steel mold.	
POM (Polyoxymethyle-ne)/ Hostaform C9021	+50 Shots	Projected for 100+ shots. Test was ended for time reasons, with the mold regarded as essentially undamaged. The process required no release agent (beyond initial impregnation). Produced parts maintained a glossy surface, indicating very little abrasive wear on the tool surface.	
PPGF30 (Glass fiber reinforced Polypropylene)/ Altech PA6 A 2030/319 GF30	+159 Shots	Projected for 200+ shots. Test series was concluded due to time limitations, only minor detail chipping occurred, with no widespread material breakouts. The quality of the components remained largely consistent throughout the test duration. Low material adhesion allowed the tool to be operated without the need for additional mold release agents.	

In summary: The ATARU resin confirmed its fundamental suitability for additive toolmaking, demonstrating that it can successfully process thermoplastics such as ABS, PPGF30, and

Key Result 3: Challenges with Polar Thermoplastics

Strongly polar materials like Polyamide 6 (PA6) and Polycarbonate (PC) caused most rapid tool failure due to strong material shots. The service life for PA6 was 22–23 shots. While PC initially failed after 23 shots, using a silicone oil release agent significantly extended its operational life to 50 shots, suggesting mitigation strategies are viable for challenging materials.

Shot 41 of 50 from injection molding test series with PC (using silicone oil as a release agent).

Conclusion

In summary, the feasibility study confirms the fundamental suitability of ATARU resin for additive toolmaking. The resin provides excellent replication of geometry, enabling the successful processing of several common thermoplastics.

Key Findings on Suitability:

- **Weakly polar materials** (ABS, POM, PPGF30) can be processed well, often reaching over 100 shots (estimated), demonstrating that the material can handle the associated mechanical and thermal stresses.
- The resin exhibits sufficient elongation at break to be tightly sealed during molding without immediate cracking.
- The tool inserts can be adequately machined to size by planning and reaming.