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Recommended Approaches for Using Rapid 3DShield™ Tungsten & Boron Carbide Filaments for Radiation Shielding

Executive Summary

Rapid 3DShield™ Tungsten and Boron Carbide Filaments provide a versatile, customizable approach to radiation shielding across medical, nuclear, and research environments. These materials are designed to be used in their green (unsintered) state and can be printed on most open-architecture FDM 3D printers, offering on-demand, application-specific protection solutions. This paper outlines recommended practices for their use, summarizes test data, and highlights key applications.

Introduction

Radiation shielding has historically relied on heavy, difficult-to-manufacture materials like lead or steel. Rapid 3DShield™ Tungsten and Boron Carbide Filaments combine high-density or neutron-absorbing media with an easy-to-print polymer binder. This allows engineers and technicians to rapidly design and produce custom shielding components that fit exactly where needed.

After seven years on the market, Rapid 3DShield Tungsten Filament has demonstrated proven performance in nuclear power facilities, and research labs. Rapid 3DShield Boron Carbide Filament—launched nine months ago—extends these capabilities into neutron absorption applications.

Material Overview

Rapid 3DShield™ Tungsten Filament

- Formats: Spools (1.75mm & 2.85mm; 0.5kg, 1kg, 3kg, and 5kg), Pellets (1kg, 3kg, and 5kg)
- Density: 7.80–8.4 g/cc
- Metal Content: 91–93% pure tungsten
- Nozzle Requirements: 0.6 mm hardened steel
- Printer Compatibility: Prints like PLA on open-architecture printers
- Post-Processing: Not sintered; used in green state
- Radiation Type: Primarily X-ray and gamma shielding

Rapid 3DShield™ Boron Carbide Filament

- Formats: Spools (0.25kg & 0.5kg), Pellets (1kg)
- Density: 1.3–1.5 g/cc
- Ceramic Content: 50–60% Boron Carbide

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- Nozzle Requirements: 0.6 mm hardened steel
- Printer Compatibility: Prints like PLA on open-architecture printers
- Post-Processing: Not sintered; used in green state
- Radiation Type: Neutron absorption

Radiation Shielding Performance

Tungsten Filament Performance

Rapid 3DShield™ Tungsten has been tested against lead from 100 kV to 450 kV. The attached data (Fig. 1) compares 3D printed tungsten to machined lead under X-ray energies from 100 kV to 180 kV. Our testing shows that fully dense (100% infill) tungsten prints provide shielding performance comparable to machined lead at similar thicknesses.

Important Note: Shielding effectiveness varies with infill type and percentage. Thicker walls and higher infill densities yield more effective shielding.

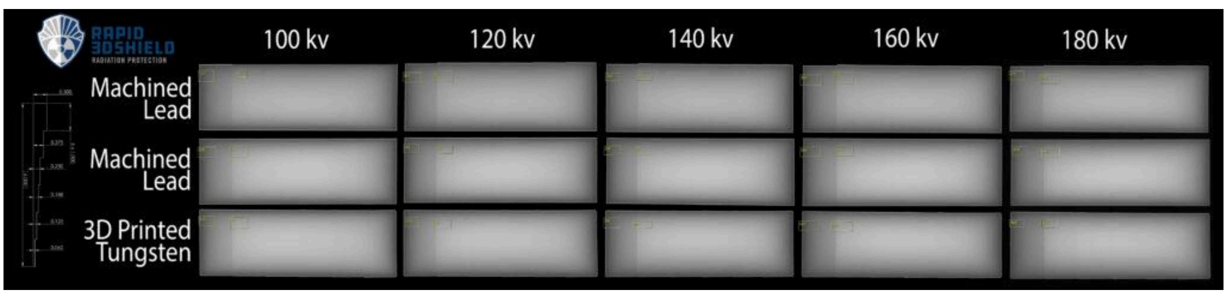

Fig. 1

Boron Carbide Filament Performance

Boron Carbide Filament is optimized for neutron absorption. While we do not have any testing data for this material at this time, it has been used by Los Alamos National Lab, Thermo Fisher Scientific, and a few university labs.

Applications

Medical

Originally designed for cancer treatment environments, Rapid 3DShield™ Tungsten Filament is suitable for shielding diagnostic or therapeutic equipment and protecting staff or patients from stray radiation.

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Nuclear Power

Tungsten Filament has been adopted for shielding temporary "hot spots" in reactor cooling channels and other high-radiation zones. The ability to rapidly print custom geometries makes it particularly valuable for temporary or hard-to-fit locations.

Research & Development

Boron Carbide Filament enables neutron shielding in laboratory and experimental environments, supporting flexible prototyping and small-batch production.

Press Release: 3D Printable Tungsten Filament

Recommended Printing & Design Practices

- **Use Hardened Nozzles:** A 0.6 mm hardened steel nozzle is required to handle the abrasive nature of both filaments. Stainless steel, tungsten, brass, titanium, and ruby nozzles have been tested and found to wear faster than a hardened steel nozzle.
- **Print at High Infill:** 100% infill is recommended for maximum shielding. Lower infill may be acceptable depending on the application but reduces effectiveness.
- **Design for Thickness:** Shielding scales with material thickness. Add wall thickness or multiple perimeters for higher attenuation.
- **Plan for Modularity:** Consider printing interlocking or modular pieces to form larger shielding barriers.
- **Verify with Testing:** Always test final parts under the expected radiation conditions to validate performance.

Safety and Handling

Both filaments are safe to handle in their green state. All metal or ceramic powders are fully contained within a plastic binder. Safety Data Sheets (SDS) are available on our website.

Advantages Over Traditional Shielding

- **Custom Geometry:** 3D printing enables parts tailored to the exact space or equipment.
- **Rapid Production:** On-demand printing avoids long lead times for machined parts.
- **Material Safety:** No lead exposure and no free powder handling required.
- **Cost-Effective Prototyping:** Ideal for small batches or iterative designs. Combined with a high speed 3D printer, larger parts or batches can be completed quickly.

Conclusion

Rapid 3DShield™ Tungsten and Boron Carbide Filaments bring proven radiation shielding performance to the flexibility of additive manufacturing. By following best practices—high infill, proper nozzle selection, and thoughtful part design—users can create safe, effective shielding components tailored to their needs.

Printing instructions here.
Radiation testing data for tungsten here.

Contact The Virtual Foundry for more information and to order.
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