Electrifi 101

A practical guide to understanding Electrifi, its material behavior, application potential, and how to achieve the best results

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Part 1: What Is Electrifi?

Electrifi is a family of **highly electrically conductive thermoplastic materials** developed by Multi3D to bridge the gap between traditional electronics and additive manufacturing. Unlike conventional "conductive" filaments that rely on carbon fillers, Electrifi uses a **percolated copper network** embedded in a polymer matrix, enabling conductivity levels much closer to metals while remaining processable by 3D printing and other polymer manufacturing methods.

Electrifi is designed to function as a **conductive structural material**—allowing electrical pathways, contacts, and functional features to be printed directly into plastic parts.

Part 2: Why Electrifi Is Fundamentally Different

Most commercial conductive filaments are carbon-based (carbon black, graphene, or carbon fiber). While useful for ESD or sensing, these materials typically exhibit conductivities in the range of **1–1,000 S/m**, which is insufficient for many real electronic functions.

Electrifi's copper-filled composite formulation achieves:

- **Electrical conductivity:** ~1,000–100,000 S/m
- **Volume resistivity:** as low as ~0.001 Ω·cm

This represents **orders of magnitude improvement** over carbon-based plastics and enables applications such as printed conductors, sockets, heaters, antennas, and EMI structures.

Part 3: Understanding the Material Physics

Metal–Polymer Composite Behavior

Electrifi is not a metal wire and not a conventional plastic—it is a **metal–polymer composite**. Electrical performance depends on:

- Copper loading and particle connectivity
- Polymer matrix behavior
- Print geometry and orientation
- Contact pressure at interfaces

As a result:

- **Trace geometry matters** (wider and thicker traces conduct better)
- **Contact resistance often dominates system performance**
- Electrifi should not be treated as a solder replacement

Temperature Effects

Electrifi exhibits a **positive temperature coefficient of resistance (PTCR)**—resistance increases with temperature due to polymer expansion affecting copper particle contacts. Excessive heat can temporarily or permanently increase resistance.

Different Electrifi formulations use different base polymers:

- **Polyester-based Electrifi:** optimized for low-temperature printing (140–160 °C), suitable for room temperature applications
- **Conductive PE Electrifi:** higher thermal stability, suitable for continuous use up to ~85 °C

Part 4: Printing with Electrifi – What Matters Most

Printer Compatibility

Electrifi prints best on **direct-drive FFF printers** with:

- Short, well-constrained filament paths
- Minimal filament tension

Not recommended:

- Bowden-style extruders
- AMS or shared-path multi-material systems

Key Printing Principles

To achieve the best electrical and mechanical results:

- **Use low print speeds** (typically 10–30 mm/s)
- **Minimize or disable retraction**
- **Use larger nozzles** (≥0.4 mm, preferably 0.6 mm)

- **Avoid prolonged heat exposure** in the nozzle

Cooling Strategy (Critical)

- Part cooling fan should be OFF (0%) at all times for Electrifi Conductive PE Filament
- Forced cooling reduces interlayer bonding and can degrade conductivity
- Strong **hotend heat-break cooling** is essential to prevent heat creep

Bed and Adhesion Notes

- Polyester-based Electrifi adheres well to painter's tape, PLA, and PETG
- **Conductive PE Electrifi adheres best to PE and PP**
- Adhesion to PLA, ABS, or PETG with conductive PE may be limited without surface treatment or mechanical interlocking

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Part 5: Designing for Electrical Performance

Electrifi delivers the best results when designs follow these rules:

- Use **wide, thick traces** whenever possible
- Minimize conductor length
- Use **100% infill** for conductive features
- Design interfaces to apply **mechanical compression**

For component attachment:

- Mechanical sockets
- Press-fit features
- Conductive epoxies or low-temperature metal alloys (e.g., Field's metal)

These approaches outperform thin traces or point contacts.

Part 6: What Electrifi Is (and Is Not)

Electrifi is:

- A highly conductive printable material
- Ideal for embedded electronics and functional prototypes
- A platform for exploring new manufacturing approaches

Electrifi is not:

- A drop-in replacement for copper wire

- A conventional solderable metal
- A high-speed commodity filament

Understanding this distinction is key to success.

Part 7: Application Potential

When used correctly, Electrifi enables:

- Printed conductors and interconnects
- Embedded heaters and thermal elements
- Antennas and RF structures
- EMI shielding and grounding paths
- Smart enclosures, wearables, and research prototypes

Electrifi is especially powerful in applications where **geometry, integration, and rapid iteration** matter more than absolute bulk conductivity.

Final Takeaway

Electrifi opens a new design space where **electrical functionality becomes part of the printed structure itself**. Success comes from understanding the material's composite nature, designing for contact and geometry, and printing with care rather than speed.

When these principles are followed, Electrifi enables capabilities that are difficult or impossible to achieve with traditional electronics manufacturing.

For detailed datasheets, printing parameters, and application support, please contact Multi3D, Inc.