

Acetone vs Wire Heated Gun 3D Printing Parts Assembly

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Abstract

The increasing adoption of 3D printing has led to a demand for efficient methods of assembling 3D-printed parts. Two common methods include using acetone and a wire-heated gun. This research compares these methods regarding efficiency, durability, ease of use, and filament compatibility. The study provides insights into the best techniques for assembling different 3D-printed materials while considering their structural integrity. The results offer recommendations for manufacturers and hobbyists seeking optimal assembly methods.

Keywords: 3D printing, acetone, wire heated gun, filament, assembly, plastic welding, 3D-printed part joining, solvent welding, heat welding.

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Abbreviations

ABS:	Acrylonitrile Butadiene Styrene
PLA:	Polylactic Acid
PETG:	Polyethylene Terephthalate Glycol
TPU:	Thermoplastic Polyurethane
FDM:	Fused Deposition Modeling
HIPS:	High Impact Polystyrene
DIY:	Do It Yourself
SLA:	Stereolithography

I. Introduction

3D printing, as shown in Figure 1, also known as additive manufacturing, has revolutionized the way objects are designed and manufactured across various industries. This technology has enabled rapid prototyping, custom part production, and cost-effective manufacturing in fields such as aerospace, medical devices, automotive, and consumer goods. However, despite the advantages of 3D printing, limitations in print size and design complexity often necessitate the assembly of multiple printed components into a single structure.

Joining 3D-printed parts is a crucial process that ensures structural integrity, functionality, and aesthetic appeal. Various techniques are used for assembling 3D-printed parts, including mechanical fastening, adhesive bonding, chemical welding, and heat welding. Among these

methods, two of the most widely used techniques are acetone welding and heat welding using a wire-heated gun. Each method offers unique benefits and drawbacks, depending on the type of filament used, the strength of the required bond, and the application.

Acetone welding is a chemical fusion technique primarily used for ABS and similar filaments. It works by dissolving the surface layers of the plastic, allowing the parts to merge into a single, seamless structure. This method is known for its strong molecular bonding and smooth finish, making it ideal for applications requiring an aesthetically refined surface.

On the other hand, heat welding with a wire-heated gun is a mechanical fusion technique that involves melting the edges of 3D-printed parts to create a strong joint. This technique applies to a broader range of materials, including PLA, PETG, and ABS. It provides rapid bonding and structural strength, though it requires precision to avoid excessive melting and surface imperfections.

This research aims to provide a comprehensive comparison between acetone welding and heated gun welding for assembling 3D-printed parts. It will evaluate factors such as material compatibility, bond strength, ease of application, safety, cost, aesthetic finish, and long-term durability. By examining these criteria, this

study seeks to determine the optimal assembly method for various use cases and provide recommendations for hobbyists, engineers, and manufacturers who rely on 3D printing for prototyping and production.

3D Printing Overview

3D printing is a process of creating three-dimensional objects by depositing material layer by layer. The most common type of 3D printing is Fused Deposition Modeling (FDM), which uses thermoplastic filaments, as shown in *Figure 2*. The process begins with a digital 3D model, which is sliced into layers by software. The 3D printer then extrudes the filament through a heated nozzle, building the object layer by layer.

3D printing is widely used in various industries, including aerospace, automotive, healthcare, and consumer goods. Its ability to produce complex geometries and reduce material waste makes it a valuable tool for prototyping and small-scale production.

Types of Filaments Used in 3D Printing

The choice of filament significantly impacts the assembly process. Below are the most common filaments used in 3D printing, along with their characteristics, advantages, disadvantages, and joining effects.

1. ABS (Acrylonitrile Butadiene Styrene)

Characteristics: Durable, impact-resistant, and heat-resistant.

Advantages: Strong and versatile, suitable for functional parts.

Disadvantages: Prone to warping and emits fumes during printing.

Joining Effects: Excellent for acetone welding due to its solubility in acetone.

2. PLA (Polylactic Acid)

Characteristics: Biodegradable, easy to print, and rigid.

Advantages: Environmentally friendly and user-friendly.

Disadvantages: Brittle and less heat-resistant.

Joining Effects: Not suitable for acetone welding; best joined with adhesives or mechanical fasteners.

3. PETG (Polyethylene Terephthalate Glycol)

Characteristics: Strong, flexible, and chemical-resistant.

Advantages: Combines the strength of ABS with the ease of printing of PLA.

Disadvantages: More challenging to print than PLA.

Joining Effects: Can be joined with specialized adhesives or thermal methods.

4. TPU (Thermoplastic Polyurethane)

Characteristics: Flexible, elastic, and durable.

Advantages: Ideal for flexible parts and prototypes.

Disadvantages: Difficult to print due to its flexibility.

Joining Effects: Best joined with adhesives or thermal welding.

3D Printing Parts Assembly

Assembling 3D-printed parts is often necessary to create larger or more complex structures. This can be done using mechanical fasteners, adhesives, or welding techniques. The choice of assembly method depends on factors such as material compatibility, required strength, and ease of use. Acetone bonding and wire-heated gun assembly are two popular methods for joining thermoplastic parts, each with its own set of advantages and disadvantages.

Acetone 3D Printing Parts Assembly

Process Overview

Acetone bonding is a chemical method used primarily for ABS plastic. Acetone acts as a solvent, dissolving the surface of the ABS parts and allowing them to fuse together as the acetone evaporates. The process, as shown in *Figure 3*, involves applying a small amount of acetone to the surfaces to be joined and pressing them together until the bond sets.

Step-by-Step Guide

1. Preparation: Ensure the surfaces to be bonded are clean and free of dust or grease.

2. Application: Apply a small amount of acetone to the surfaces using a brush, syringe, or cotton swab.

3. Joining: Press the parts together firmly, ensuring proper alignment.

4. Curing: Allow the bond to cure for several hours, depending on the size and strength required.

Tips for Optimal Results

- Ventilation: Work in a well-ventilated area to avoid inhaling acetone fumes.

- Consistency: Apply acetone evenly to avoid weak spots in the bond.

- Clamping: Use clamps or weights to hold the parts together while the bond sets.

Heated Gun 3D Printing Parts Assembly

Process Overview

A wire-heated gun, often referred to as a soldering iron, as shown in *Figure 4*, or a hot air gun, as shown in *Figure 5*, is used to melt the plastic surfaces of 3D-printed parts, allowing them to fuse

together. This method is versatile and can be used with a variety of thermoplastics, including ABS, PLA, and HIPS.

Step-by-Step Guide

1. Preparation: Clean the surfaces to be bonded and ensure they fit together properly.
2. Heating: Set the heated gun to the appropriate temperature for the material being used.
3. Melting: Gently heat the edges of the parts until they begin to melt.
4. Joining: Press the melted surfaces together and hold until they cool and solidify.

Tips for Optimal Results

- Temperature Control: Use the correct temperature setting to avoid burning the plastic.
- Precision: Focus the heat on the edges to be joined, avoiding excessive melting.
- Safety: Wear protective gloves and work in a well-ventilated area to avoid burns and fumes.

Comparison Between Acetone and Heated Gun 3D Printing Parts Assembly

In this section, we will delve deeper into the comparison between acetone welding and heated gun assembly for 3D-printed parts. The comparison will focus on key aspects such as material compatibility, joint strength, ease of use, cost, safety, and application suitability. This detailed analysis will help users make informed decisions based on their specific needs.

1. Material Compatibility

Acetone Welding

- Compatible Materials: Acetone welding is primarily effective with ABS (Acrylonitrile Butadiene Styrene) and a few other acetone-soluble materials like HIPS (High-Impact Polystyrene).
- Incompatible Materials: PLA, PETG, TPU, and other non-acetone-soluble filaments cannot be joined using this method.
- Limitations: The process is highly material-specific, making it unsuitable for multi-material projects or assemblies involving non-ABS parts.

Heated Gun Assembly

- Compatible Materials: A heated gun can be used with almost all thermoplastic filaments, including ABS, PLA, PETG, TPU, Nylon, and more.
- Versatility: This method is ideal for projects involving multiple materials or specialized filaments.
- Limitations: While versatile, the effectiveness of the joint may vary depending on the material's melting point and thermal properties.

2. Joint Strength

Acetone Welding

- Strength: Acetone welding creates strong, seamless joints that are often as strong as the original material. The solvent dissolves the surface layers of the parts, allowing them to fuse together at a molecular level.
- Durability: Joints are highly durable and resistant to mechanical stress, making them suitable for functional parts.
- Limitations: If not applied correctly, acetone welding can weaken the material or create uneven joints.

Heated Gun Assembly

- Strength: Heated gun assembly produces strong, heat-resistant joints by melting the material and fusing it together. The strength of the joint depends on the user's skill and the temperature control of the tool.
- Durability: Joints are durable but may be slightly weaker than acetone-welded joints due to potential inconsistencies in melting.
- Limitations: Overheating can degrade the material, while insufficient heat can result in weak joints.

3. Ease of Use

Acetone Welding

- Simplicity: Acetone welding is relatively simple and does not require specialized equipment. The process involves applying acetone to the joining surfaces and pressing the parts together.
- Learning Curve: Minimal skill is required, making it accessible to beginners.
- Precision: Achieving precise joints can be challenging, especially for small or intricate parts.

Heated Gun Assembly

- Complexity: Heated gun assembly requires more skill and practice to achieve consistent results. Users must control the temperature and apply the tool evenly to avoid damaging the material.
- Learning Curve: Steeper learning curve compared to acetone welding.
- Precision: Offers greater precision, especially for small or complex assemblies, but requires steady hands and experience.

4. Cost

Acetone Welding

- Equipment Cost: Acetone is inexpensive and widely available. No specialized tools are required.
- Operational Cost: Low operational cost, as only a small amount of acetone is needed for each joint.
- Overall Cost: One of the most cost-effective methods for assembling ABS parts.

Heated Gun Assembly

- Equipment Cost: A high-quality heated gun or soldering iron can be expensive, especially models with adjustable temperature settings.
- Operational Cost: Minimal operational cost, but the initial investment in equipment is higher.
- Overall Cost: More expensive than acetone welding, but the versatility justifies the cost for many users.

5. Safety

Acetone Welding

- Health Risks: Acetone is a volatile organic compound (VOC) that can cause respiratory irritation, dizziness, and skin irritation. Proper ventilation and protective equipment (gloves, masks) are essential.
- Fire Hazard: Acetone is highly flammable and should be stored and used away from open flames or sparks.
- Environmental Impact: Acetone is not environmentally friendly and should be disposed of properly.

Heated Gun Assembly

- Health Risks: The primary risk is burns from the heated tool or molten plastic. Proper handling and protective gear (gloves, safety glasses) are necessary.
- Fire Hazard: The heated gun itself poses a fire hazard if left unattended or used near flammable materials.
- Environmental Impact: Minimal environmental impact compared to acetone, as no chemicals are involved.

6. Application Suitability

Acetone Welding

- Best For: Acetone welding is ideal for ABS parts and projects requiring strong, seamless joints. It is commonly used in functional prototypes, automotive parts, and enclosures.
- Not Suitable For: Projects involving non-ABS materials or multi-material assemblies.

Heated Gun Assembly

- Best For: Heated gun assembly is suitable for multi-material projects and applications requiring versatility and precision. It is commonly used in artistic models, flexible parts (TPU), and complex assemblies.
- Not Suitable For: Beginners or users without access to a high-quality heated gun.

7. Surface Finish

Acetone Welding

- Finish: Acetone welding often leaves a glossy, smooth finish on the joint, which can be aesthetically pleasing.
- Post-Processing: Minimal post-processing is required, as the joint is usually seamless.
- Limitations: The glossy finish may not match the texture of the rest of the part, requiring additional sanding or painting.

Heated Gun Assembly

- Finish: The finish depends on the user's skill. Well-executed joints can be nearly seamless, while poorly executed joints may have visible marks or uneven surfaces.
- Post-Processing: This may require sanding or smoothing to achieve a uniform appearance.
- Limitations: Achieving a perfect finish requires practice and precision.

8. Speed of Assembly

Acetone Welding

- Speed: Acetone welding is relatively fast, as the solvent evaporates quickly, allowing the joint to set within minutes.
- Curing Time: Joints typically cure within 10-15 minutes, depending on the amount of acetone used.
- Limitations: Excessive acetone can prolong curing time.

Heated Gun Assembly

- Speed: The process can be slower, as it requires careful heating and alignment of the parts.
- Curing Time: Joints set almost immediately but may require cooling time to achieve full strength.
- Limitations: The speed depends on the user's skill and the complexity of the assembly.

Summary of Advantages and Disadvantages

Acetone Welding	
Advantages	Disadvantages
Strong, seamless joints	Limited to ABS and a few other materials
Easy to use, minimal skill required	Health and safety concerns
Cost-effective	Glossy finish may not match part texture
Fast curing time	Not suitable for multi-material projects

Heated Gun Assembly	
Advantages	Disadvantages
Versatile, works with most filaments	Requires skill and practice
Strong, heat-resistant joints	Higher equipment cost
Precise control over the process	Risk of burns and fire hazards
Suitable for complex assemblies	Slower process compared to acetone

II. Conclusion

Both acetone welding and heated gun assembly are effective methods for joining 3D-printed parts, but each has its strengths and limitations. Acetone welding is ideal for ABS parts and offers strong, seamless joints with minimal equipment. However, its limited material compatibility and health concerns make it less versatile. On the other hand, heated gun assembly is more versatile and can be used with a wide range of filaments, but it requires skill and specialized equipment.

III. Recommendations

- For ABS Parts: Use acetone welding for strong, cost-effective, and easy-to-use assembly.
- For Multi-Material Projects: Opt for a heated gun assembly to handle a variety of filaments and achieve precise joints.
- For Beginners: Start with acetone welding for ABS parts to gain experience before moving on to heated gun assembly.
- For Professionals: Invest in a high-quality heated gun for maximum versatility and precision in complex projects.

By understanding the strengths and limitations of each method, users can choose the most appropriate assembly technique for their specific needs, ensuring strong, durable, and aesthetically pleasing results.

This research provides a detailed comparison of acetone and wire-heated gun assembly methods, helping users make informed decisions based on their specific needs. By understanding the advantages and disadvantages of each technique, 3D printing enthusiasts and professionals can achieve stronger, more reliable assemblies for their projects.

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Figures

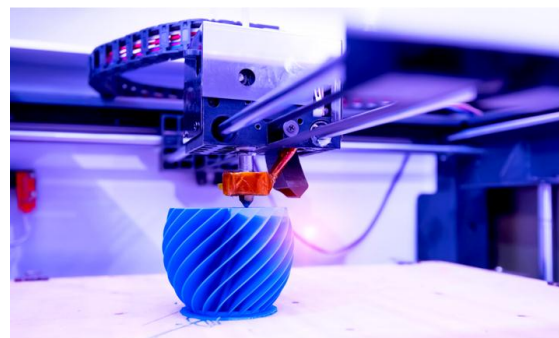


Figure 1. 3D Printing.



Figure 2. 3D printing filaments



Figure 3. Acetone 3D Printing Parts Assembly



Figure 4. Soldering Iron Heated Gun for 3D Printing Parts Assembly



Figure 5. Hot Air Gun for 3D Printing Parts Assembly