

Brazing Safety: Combustibility of Metal Powders

In the form of powders and pastes, brazing filler metals are potentially explosive. Safe handling requires estimation of risk level, proper handling technique, explosion and fire prevention methods, and fire fighting techniques.

The U.S. Bureau of Mines ranks the probability of explosion as severe, strong, moderate, weak, or none. Aluminum and magnesium powders have a severe rating. They are aggressive reducing agents whose reactions occur with a drastic release of energy (see Table 1). Therefore, aluminum or magnesium dust is five to ten times more dangerous than the coal or flour dusts that cause destructive explosions in mines and silos. An aluminum dust cloud will ignite with as little as 9% oxygen with the balance being nitrogen, and 3% oxygen with the balance being carbon dioxide.

Because stainless steel, copper, and nickel do not oxidize readily, they and their powders are low on the explosivity list. Titanium and zirconium powders have a strong risk of self-combustion and are considered highly flammable. Zinc is also on the list of pyrophoric metals, but it will burn in air only at elevated temperatures.

Ignition temperatures of titanium dust clouds in air range from 63° to 1090°F (332°–588°C), and titanium dust that has accumulated on the floor or equipment from 720° to 950°F (382°–510°C).

The explosibility of powders depends on particle size. For example, aluminum powder having less than 10 vol-% of particles with the size –200 mesh has no explosion hazards, but above 40 vol-%, the explosion probability is severe.

How Explosions Can Occur

Fire or explosion typically occurs when metallic dust or micron-sized powders accumulate in an area containing the following:

1. Ignition sources such as working torches, electrical devices, gaseous furnaces, and spark-generating equipment
2. A weak ventilation system
3. Vapors of flammable liquids such as alcohol, acetone, organic binders, or cleaning liquids
4. Oxygen-containing agents such as metal peroxides, inorganic nitrates, chlorates, perchlorates, persulfates, bromates, cyanurates, and azines; pyrochloric materials, leakage from an oxygen pipeline; etc.

Cleanliness requirements are particularly exacting for reactive fine metal powders such as aluminum, magnesium, titanium, and zirconium since concentrations as low as 23–40 g/m³ can lead to ignition (Table 1).

How to Prevent Fire or Explosions of Brazing Powders

Preventive measures include the following:

1. Preventing the formation of dust clouds when handling explosive powders
2. Not allowing dust to accumulate from grinding, screening, or brazing operations
3. Using natural hair brushes (not plastic or metal brushes) to clean up the work area

Excerpted from the *Brazing Handbook*, fifth edition.

Table 1 — Relative Explosibility of Various Dusts

Material	Lower Explosive Limit oz/ft ³ (g/m ³)	Rate of Pressure Rise lb/in. ² /s (MPa/s)
Aluminum	0.045 (35.33)	20,000 (138)
Magnesium	0.030 (23.00)	15,000 (103)
Titanium	0.051 (40.00)	N/A
Bronze	0.955 (750.00)	1,494 (10)
Zinc	0.318 (250.00)	6,024 (42)
Polyethylene	0.020 (15.70)	7,500 (52)
Corn flour	0.050 (39.25)	3,700 (26)
Coal	0.050 (39.25)	2,000 (14)

Sources: Unal, A., D. D. Leon, T. B. Gurganus, and G. J. Hildeman, 1998, Production of Aluminum and Aluminum-Alloy Powders Applications, in *Powder Metal Technologies and Applications*, Vol. 7 of *ASM Handbook*, Materials Park, Ohio, ASM International, pp. 148–159; O’Laughlin, R., 1999, Metals, in *Fire Protection Handbook*, 17th ed., Quincy, Mass.: National Fire Protection Association; Lowley, A. 1992, *Atomization*, Princeton, N.J., Metal Powder Industries Federation.

4. Refraining from using plant air to blow away powder residues and dust
5. Eliminating and controlling ignition sources
6. Prohibiting smoking
7. Electrically grounding all equipment
8. Ensuring all switches are dust tight and explosion proof
9. Prohibiting arc and torch welding or brazing in the powder handling area
10. Using tightly closed metal containers for powder storage.

What to Do in the Event of a Fire or Explosion

1. Evacuate the area and let the fire run its course.
2. For small, localized fire, initiate the alarm procedure and try to extinguish the fire using only Class D fire-fighting means such as dry salt (NaCl) powder, dry graphite, talc, dolomite and limestone powders, or specialized means like graphite-based Pyrene G-1 powder, and NaCl-based Met-L-X and Pyromet powders. Clean, dry cast iron chips or borings, and copper powder are also suitable as extinguishing agents.
3. DO NOT USE WATER or carbon dioxide for such powders as aluminum, magnesium, titanium, and zirconium. Flooding with the noble gases helium or argon will extinguish burning magnesium.
4. Use proper protective clothing and respirators because some metals are toxic if they enter the bloodstream or their smoke fumes are inhaled.

A fire of brazing filler metals in paste form usually begins as a solvent fire. A solvent fire can be fought with Class B extinguishing agents, but halogenated or vaporizing liquid agent must never be used. If the fire accelerates after the extinguishing agent is applied, which should be very evident, the use of Class B extinguishing agent should be discontinued and dry Class D agents should be used because the fire then will be considered a powder fire. It is dangerous to use a water hose stream to fight a paste fire. ♦