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Getter Materials

By Dan Herring

Experience has shown us that sensitive materials in the presence of contaminants can destroy the integrity and shorten the life expectancy of a part. What can be done to further protect the work in a vacuum furnace? The answer is reducing the chamber pressure to as low as is economically feasible on getter materials.

What is a Getter?

A getter is simply a reactive material that is deliberately placed in a vacuum furnace to increase the efficiency of that vacuum by scavenging unwanted contaminants. As they combine with it chemically or by adsorption so as to be re-eliminated, the getter eliminates even minute amounts of unwanted gases from the vacuum.

Getter materials fall into three broad categories: bulk getters, coatings, and surface getters. From simple foils, wraps and stamped forms to machined turning and coatings applied to the surface in the form of coatings or placed in the gas stream of a vacuum furnace whether graphite or metallic (e.g. molybdenum and/or titanium) are especially important when processing reactive metals such as titanium, zirconium, niobium, tantalum, and the like. The sophistication of the gettering process has advanced significantly over the years.

Getter Properties

The action of a getter material depends on:

- Adsorption (i.e. accumulation of gas molecules at the surface)
- Absorption (i.e. diffusion of gas molecules in the solid);
- Chemical binding (i.e. reaction with the surface atoms).

A getter material is designed to react with the gas species present, creating a chemical reaction. Typical gases present in vacuum systems are carbon monoxide (CO), carbon dioxide (CO₂), nitrogen (N₂), hydrogen (H₂), and water vapor (H₂O). Most metal surfaces have a protective oxide on them, which under vacuum and at high temperatures must dissolve and diffuse into the getter material before it can be effective. Thus a getter material must also have the ability to prevent the diffusion of contaminating gases once they have been absorbed.

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Getters bind gases on their surfaces. Thus, the greater the surface area, the more gas they can bind.

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VACUUM FURNACE SPECIFICATIONS



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Vertical Gas Quench Furnace Specifications

Getter Material	Gas species	Getter Capacity (Pa-l/mg)
Aluminum	Oxygen (O ₂)	1.00
Barium	Carbon Dioxide (CO ₂)	0.69
	Hydrogen (H ₂)	11.50
	Nitrogen (N ₂)	1.26
	Oxygen (O ₂)	2.00
Magnesium	Oxygen (O ₂)	2.70
Rare Earth Elements (cerium, lanthanum)	Carbon Dioxide (CO ₂)	0.29
	Hydrogen (H ₂)	6.13
	Nitrogen (N ₂)	0.43
	Oxygen (O ₂)	2.80
Titanium	Hydrogen	27.00
	Nitrogen	0.85
	Oxygen	4.40

Table 1 [1] Getter Capacity of Common Materials

10¹⁸ particles (i.e. 6.7 x 10¹⁸ hydrogen molecules or 1.34 x 10¹⁹ hydrogen atoms) and 10¹⁹ titanium atoms so that each titanium atom in the getter corresponds to 10¹⁹ hydrogen atoms.

The chemical reactions (in simplified form) are as follow (here GM represents Getter Material):

- (1) 2GM + O₂ → 2GMO
- (2) 2GM + N₂ → 2GMN
- (3) 2GM + CO → GMC + GMO
- (4) 2GM + CO₂ → CO + 2GMO → GMC + GMO
- (5) GM + H₂O → H + GMO → GMO + H (bulk)
- (6) GM + H₂ → GMH + H (bulk)
- (7) GM + C_xH_y → GMC + H (bulk)
- (8) GM + Inert Gas (He, Ne, Ar, Kr, Xe) → No reaction

Getter capacity is affected by temperature since diffusion rates of the getter material increase with temperature. This helps keep the getter surface clean by reacting with the gases that bind only to the surface due to chemical reactions. Adsorption is limited by surface saturation).


Titanium can be used as an effective getter material when running 1400°F range, titanium scrap (often in the form of clean, dry machined surfaces clean (i.e. to avoid oxidation and discoloration) during an annealing cycle.



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Non-Evaporative Getters

Non-evaporable getters have become an integral part of many ultra surface properties which are conducive to achieving extremely high or lower). Binary, ternary and multicomponent alloys from Group IV are most often used. These generally consist of a film of a special alloy materials must form a passivation layer at room temperature v have names of the form St (Stabil) followed by a number:

- St 707 - a 70% zirconium, 24.6% vanadium balance iron alloy
- St 787 - a 80.8% zirconium, 14.2% cobalt balance mischmetal
- St 101 - a 84% zirconium and 16% aluminum

In tubes used in electronics, the getter material coats plates within t getters are used within more general vacuum systems, such as in s separate pieces of equipment in the vacuum chamber, and turned c

Final Thoughts

For heat treaters, getters are often considered a last resort to help l important role in successful vacuum processing of many highly sop do a better job of understanding their role; how and where they can

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