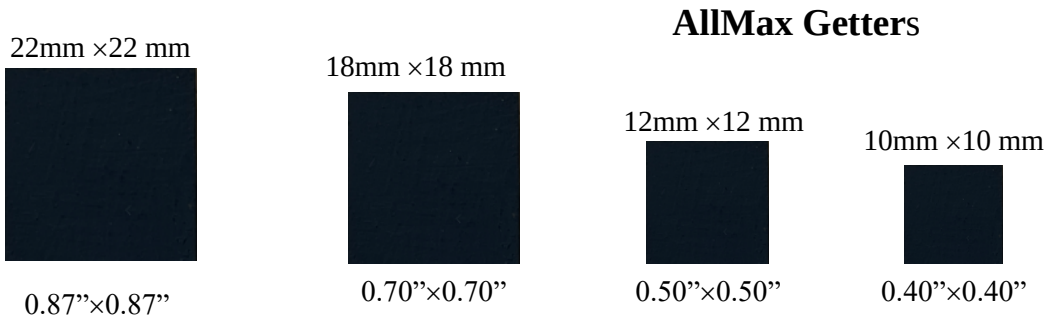
NANOFEA

NANOMAX
Getters Reimagined

AllMax Getters
(Vacuum Systems/Optic/MEMS/Hermetically Sealed Packages)



NanoFEA (Nano Functional Engineering Atmospheres) has innovatively engineered a range of multifunctional nanomaterials designed to capture a wide spectrum of gases, volatile organic compounds (VOCs), and particulate matter released by specialized electronic devices. These devices include MEMS, optical systems, lithography equipment, medical devices, semiconductors, high-power lasers, and photoelectronic packages. Featuring hierarchically porous nanostructures, these advanced materials are tailored to absorb harmful polar and non-polar gases, organic hydrocarbons, volatile organic compounds, and various particles (magnetic, electric, dielectric, fine dust/foreign object debris, and microbial contaminants), which are outgassed from vacuum equipment or hermetic packaging environments.

The NanoMax material-based gas absorption getters, protected under US Patent Application# 2025/0073666 A1 and 2025/0091030 A1, deliver a patented and cost-effective solution. Complementing this, the All-in-One AllMax Getters introduce a groundbreaking method for capturing gases, VOCs, and particles, greatly enhancing the durability and performance of electronic packages and vacuum systems. Developed and manufactured by NanoFEA, the AllMax hierarchically porous nanostructured materials provide a comprehensive getter solution, effectively eliminating all known and unknown outgassing species from vacuum systems and hermetically sealed packages.

Benefits of AllMax Getters

- Capable of absorbing both polar gases (e.g., H_2O, CO_2, CO, NH_3, SO_2) and non-polar gases (e.g., H_2, O_2, N_2, SiH_4).
- Capable of absorbing polar VOCs (e.g., Acetone (C_3H_6O), Ethanol (C_2H_6O), Methanol (CH_4O), Formaldehyde (CH_2O), Acetaldehyde (C_2H_4O), Isopropanol (C_3H_8O), Methyl Ethyl Ketone (C_4H_8O), Ethyl Axetate ($C_4H_8O_2$), and Ethyl Axetate ($C_4H_8O_2$))
- Capable of adsorbing non-polar VOCs (e.g., Benzene (C_6H_6), Toluene (C_7H_8), Xylene (C_8H_{10}), Hexane (C_6H_{14}), Ethane (C_2H_6), Propane (C_3H_8), Styrene (C_8H_8), Ethylbenzene (C_8H_{10}), Methylene Chloride (CH_2Cl_2), and Trichloroethylene (C_2HCl_3)).
- Capable of capturing particles of electric, magnetic, dielectric, fine dust/FOD, microbial contaminants
- Various Sizes: Offers standard and custom sizes to fit any packaging requirement.
- Lightweight and Low Profile: Ensures excellent performance without adding bulk.
- Easy Application: Can be applied to any surface using high-temperature adhesive films or epoxy resins of your choice.
- Wide Temperature Range: Functions efficiently from -55°C to +300°C.
- No Activation Required: Ready to use without activation or regeneration.

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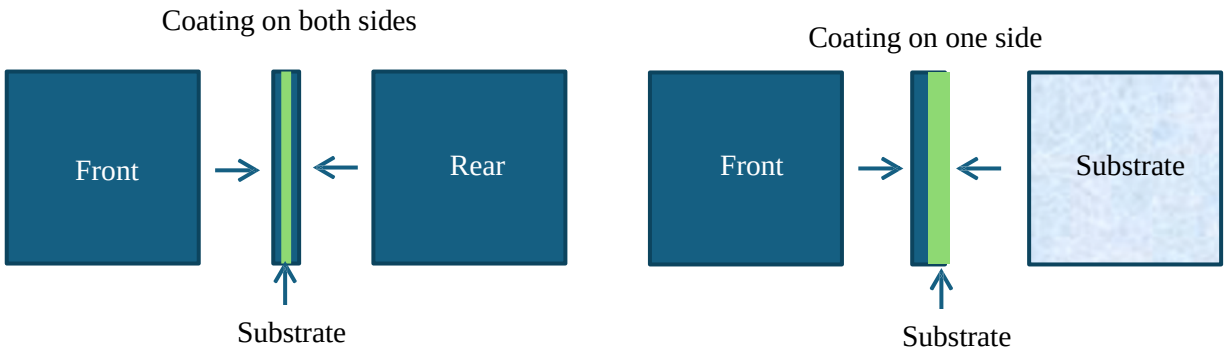
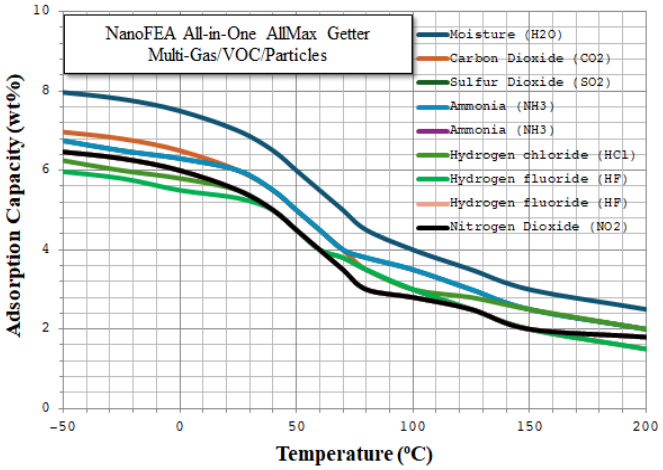


Substrate materials: Glass (borosilicate glass and silicate glass), ceramics (alumina, purity 92-99%), metals (titanium (Ti), copper (Cu), Kovar alloy, aluminum alloy).

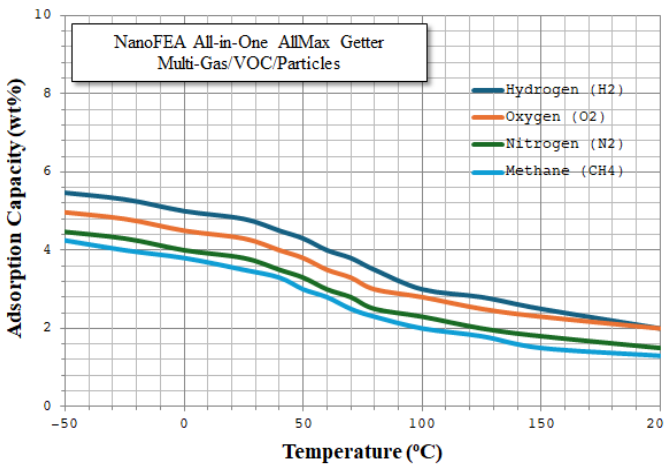
Material Physical Properties:

Density: 1.1±0.10 g/cm³ (depending upon porosity)
Dielectric constant: 2.4±0.1
Thermal conductivity: 0.25±0.05 W/m·K
Coefficient of thermal expansion (CTE): 5-7 ppm/^{o}C
Young's modulus: 5–15 GPa,
Hardness: Shore D 60-75, or ~2 GPa (Vickers)
Electric Insulation resistance: 10^{12} – 10^{14} Ω·cm
Surface energy: 30-50 mJ/m^2
The appearance of the material: Gray to off-white, light black, and black
Texture: Matte, solid, possibly slightly porous

Prime Polar Gases



Prime Non-Polar Gases



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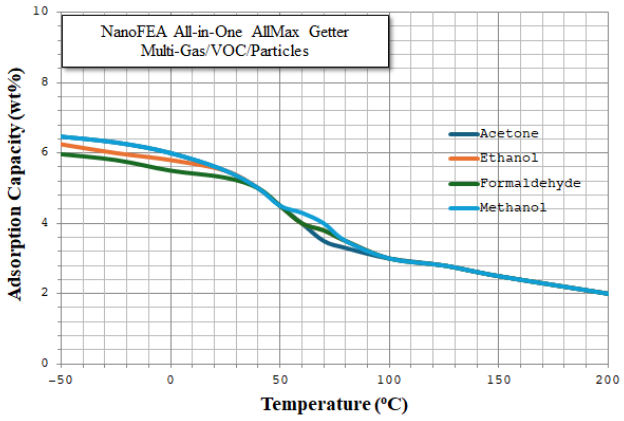
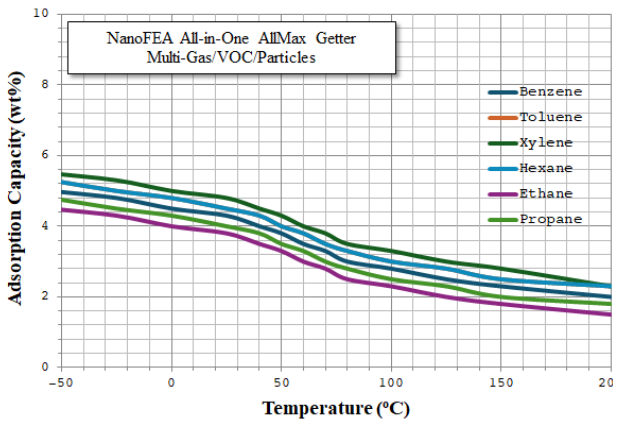
Prime Polar Organic VOCs



Prime Non-Polar Organic VOCs



Hierarchically Porous Nanostructured Composite Getters

These composite materials embed microporous nanostructures into mesoporous nanostructures, which are further embedded into macroporous structures. This concept is similar to Russian nesting dolls, where smaller structures are nested within larger ones. Hierarchically nested porous nanostructure composite getter materials have promising for being used in hermetic packaging systems, vacuum systems.

1. **Enhanced Surface Area**: The hierarchical structure combines micropores, mesopores, and macropores. This is multi-phase getter materials, which enable more efficient gas adsorption.
2. **Diverse Surface Energies**: The varying pore sizes in the hierarchical structure of AllMax materials provide diverse surface energies, improving the adsorption capability for various gases. The synergy among micropores, mesopores, and macropores not only increases surface area but also enhances the range of surface energies enabling efficient adsorption of different gases and organic VOCs.
3. **Immediate Operation without High-Temperature Activation**: Hierarchically nested porous nanostructure composite getters can operate without activation, improving practicality and energy efficiency.
4. **Absorption Mechanism**: AllMax Getters can adsorb gases not only on their surface but also within their internal nanopores (ranging from 0.3 nm to 100 nm). With a surface energy of 30–50 mJ/m², AllMax Getters efficiently adsorb both polar and non-polar gases, as well as organic hydrocarbons (HCs) and volatile organic compounds (VOCs).
5. **Vacuum Environment Applications**: Composed of inorganic materials, these getters exhibit extremely low outgassing properties. Gas absorption efficiency is optimal within medium to low vacuum pressure ranges (10^{-3} to 10^{-6} Torr) but decreases as vacuum levels increase. Due to strong van der Waals forces and electrostatic interactions with gas molecules, the structure of hierarchically porous nanostructured materials remains stable in a vacuum, allowing All-in-One AllMax Getters to maintain high absorption capacity.

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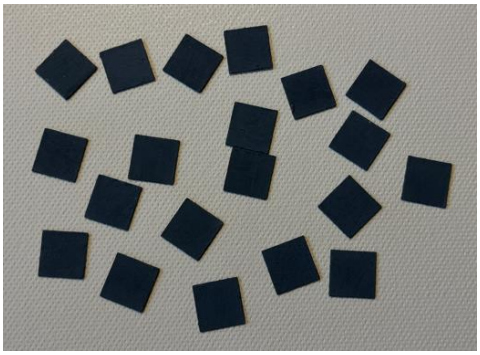
The dimensions and thickness of a getter are defined by its length, width, and thickness. As illustrated in the table below, standard getter sizes include 0.87” × 0.87” (22 mm × 22 mm), 0.70” × 0.70” (18 mm × 18 mm), 0.50” × 0.50” (12 mm × 12 mm), and 0.40” × 0.40” (10 mm × 10 mm). Customized dimensions are also available upon request. The adsorbing material typically comes in two thicknesses: 350 ± 10 µm for double-sided coatings on the substrate, and 300 ± 10 µm for single-sided coatings. For example, if the adsorption capacities for hydrogen, particle, moisture, and VOCs are known to be 1 wt%, 5wt%, 10 wt%, and 15 wt%, respectively, a getter with dimensions of 0.87” × 0.87” can adsorb 7.5 mg moisture, 0.75 mg hydrogen, 1.5 mg particles, and 11.3 mg VOCs. To ensure a safety factor of 10, an electronic package may allow a maximum outgassing quantity of 0.75 mg moisture, 0.075 mg hydrogen, 0.15 mg particles, and 1.13 mg VOCs over 20 years of operation. The actual adsorption quantity is determined by the capacity at a specific temperature, humidity, and partial pressure.

Standard Getter Sizes	Type of Getter Coating	Adsorption Material Weight (mg)	Adsorption Layer Thickness (µm)	Getter Weight (g)	Getter Thickness (µm)	1 wt% Hydrogen Adsorption (mg)	5 wt% Particle Adsorption (mg)	10 wt% Moisture Adsorption (mg)	15 wt% VOCs Adsorption (mg)
0.87"x0.87"	Double sides	75	150	0.285±0.005	350±10	0.75	1.5	7.5	11.3
	Single-side	50	100	0.260±0.005	300±10	0.50	1.0	5.0	7.5
0.70"0.70"	Double sides	50	150	0.200±0.005	350±10	0.50	1.0	5.0	7.5
	Single-side	35	100	0.185±0.005	300±10	0.35	0.7	3.5	5.3
0.50"x0.50"	Double sides	25	150	0.096±0.005	350±10	0.25	0.5	2.5	3.8
	Single-side	15	100	0.086±0.005	300±10	0.15	0.3	1.5	2.3
0.40"x0.40"	Double sides	15	150	0.065±0.005	350±10	0.15	0.3	1.5	2.3
	Single-side	10	100	0.060±0.005	300±10	0.10	0.2	1.0	1.5

Pre-use preparation: To eliminate adsorbed moisture from the getter prior to package installation, heat the getter at 80–100°C for 24–72 hours under vacuum conditions (<10^{-5} Torr). After this treatment, perform a dry N_2 or Ar purge to prevent re-adsorption of moisture before assembly.



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