time of the respective air-cleaning devices and the results are shown in FIG. 5, Table 1, and Table 2, respectively.

[146] [Table 1]

Time (min)	Ethylene Concentration (ppm)
	Example 3
0	54
10	32
20	18
30	6
40	0

[147] [Table 2]

Time (min)	Ethylene Concentration (ppm)	
	Comparative Example 7	Comparative Example 8
0	50	50
60	50	50
120	50	50
180	50	50

[148] Referring to FIG. 6~~5~~, it was confirmed that ethylene gas was completely eliminated after 6 hours by the air-cleaning device manufactured according to Example 2 when the initial concentration of ethylene gas was 60 ppm.

[149] Referring to Table 1 above, it was confirmed that ethylene gas was completely eliminated after 40 minutes by the air-cleaning device manufactured according to Example 3 when the initial concentration of ethylene gas was 54 ppm. In comparison, referring to Table 2, it was confirmed that the same concentrations of ethylene gas remained even after 180 minutes when the air-cleaning devices according to Comparative Examples 7 and 8 were used and the initial concentration of ethylene gas was 50 ppm.

[150] Therefore, it was confirmed that ethylene gas was completely removed within shorter time by the air-cleaning devices according to Examples 2 and 3 than the air-cleaning devices according to Comparative Examples 7 and 8. Furthermore, the ability of the air-cleaning device manufactured according to Example 3 to eliminate ethylene gas was considerably improved, compared to the air-cleaning device manufactured according to Example 2.

[151] (2) Evaluation of Ability to Reduce Ammonia and Acetaldehyde Gas

[152] The ability of the air-cleaning device manufactured according to Example 2 to reduce each of ammonia and acetaldehyde gas was evaluated without installing the

catalyst structure for ozone decomposition prepared according to Example 1 in the second reaction chamber. The results are shown in FIGS. 87 and 98.

[153] Referring to FIG. 87, it was confirmed that ammonia gas was completely eliminated after 30 minutes by the air-cleaning device manufactured according to Example 2 when the initial concentration of ammonia was 50 ppm. Referring to FIG. 98, it was confirmed that acetaldehyde gas was completely eliminated after 3 hours by the air-cleaning device manufactured according to Example 2 when the initial concentration of the acetaldehyde was 40 ppm.

[154] Therefore, it was confirmed that ammonia and acetaldehyde gas was completely eliminated by the air-cleaning device manufactured according to Example 2 within short time.

[155] Evaluation Example 2: Evaluation of Ability to Decompose Ozone

[156] (1) Evaluation of Ability to Decompose Ozone 1

[157] The ability of the catalyst structure for ozone decomposition prepared according to Example 1 stacked in the second reaction chamber to decompose ozone, which was generated and accumulated during a process of eliminating ethylene gas and the like in the first reaction chamber of the air-cleaning device manufactured according to Example 2, was evaluated. The results are shown in FIG. 6.

[158] Referring to FIG. 6, the catalyst structure for ozone decomposition prepared according to Example 1 installed in the second reaction chamber included in the air-cleaning device manufactured according to Example 2 exhibited an ozone concentrations of about 0.16 ppm even after 20 hours indicating a high ability to decompose ozone.

[159] (2) Evaluation of Ability to Decompose Ozone 2

[160] In a state where there was no ethylene gas around each of the air-cleaning devices manufactured according to Examples 4 to 10 and Comparative Examples 9 to 14, the ability of each of the catalyst structures for ozone decomposition respectively prepared according to Example 1 and Comparative Examples 2 to 6 and stacked in the second reaction chamber to decompose ozone was evaluated by measuring the concentration of ozone generated by the UV-C lamp installed at the center of the first reaction chamber and accumulated therein. The results are shown in Tables 3 and 4 respectively.

Claims

[Claim 1] A catalyst structure for ozone decomposition, the catalyst structure comprising:

a support comprising a porous inorganic material; and

an α-MnO_2 catalyst located on at least a portion of inner pores and a surface of the support, wherein the α-MnO_2 catalyst is fixed to the inner pores and the surface of the support in a binder-free state.

[Claim 2] The catalyst structure of claim 1, wherein the porous inorganic material comprises a porous ceramic material.

[Claim 3] The catalyst structure of claim 1, wherein the porous inorganic material comprises a porous ceramic material including 50 % or more MgO, SiO_2, and Al_2O_3 components.

[Claim 4] The catalyst structure of claim 3, wherein the porous ceramic material further comprises an alkali metal oxide.

[Claim 5] The catalyst structure of claim 1, wherein the support is a monolith.

[Claim 6] The catalyst structure of claim 1, wherein the support further comprises a material selected from glass, metal, plastic, or any combination thereof.

~~[Claim 7] The catalyst structure of claim 1, wherein the α-MnO_2 catalyst is fixed to the inner pores and the surface of the support in a binder-free state.~~

[Claim ~~8~~7] The catalyst structure of claim 1, wherein an amount of the α-MnO_2 catalyst is in the range of ~~about~~ 1 part by weight to ~~about~~ 10 parts by weight based on 100 parts by weight of the support.

[Claim ~~9~~8] The catalyst structure of claim 1, wherein the α-MnO_2 catalyst comprises α-MnO_2 particles with a diameter of ~~about~~ 50 nm to ~~about~~ 5 μm.

[Claim ~~10~~9] The catalyst structure of claim 1, wherein the catalyst structure for ozone decomposition further comprises a catalyst selected from β-MnO_2, γ-MnO_2, amorphous MnO_2, activated carbon, and any combination thereof.

[Claim ~~11~~10] A method of cleaning air, the method comprising:

a first process of reducing hazardous gas including ethylene and harmful bacteria contained in the air using a photocatalyst reactor; and

a second process of decomposing ozone generated in the first process by using one or more of the catalyst structures for ozone decomposition according to claim 1.

[Claim ~~12~~11] The method of claim ~~11~~10, wherein the photocatalyst reactor comprises:

a vacuum UV lamp; and

one or more photocatalyst structures arranged around the vacuum UV lamp.

[Claim ~~13~~12] The method of claim ~~12~~11, wherein the vacuum UV lamp comprises a UV-C lamp that emits light with wavelengths of 254 nm and 185 nm in a ratio of 9:1.

[Claim ~~14~~13] The method of claim ~~12~~11, wherein the photocatalyst structure comprises:

a substrate; and

a TiO_2 photocatalyst arranged on the substrate.

[Claim ~~15~~14] The method of claim ~~11~~10, wherein the hazardous gas comprises organic or inorganic hazardous gas comprising ethylene, ammonia, acetaldehyde, or any combination thereof.

[Claim ~~16~~15] The method of claim ~~11~~10, wherein the harmful bacteria comprises *Aspergillus brasilliensis*, *Escherichia Coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* subsp. aureus, or any combination thereof.

[Claim ~~17~~16] The method of claim ~~11~~10, wherein the one or more catalyst structures for ozone decomposition comprise~~s~~ a~~t least one~~ plurality of catalyst structures.

[Claim ~~18~~17] An air-cleaning device comprising: in a housing,

a control area;

an air inlet region;

a first reaction chamber comprising a vacuum UV lamp and one or more photocatalyst structures arranged around the vacuum UV lamp;

a second reaction chamber in which one or more of the catalyst structures for ozone decomposition according to claim 1 are~~is~~ located; and

an air outlet region.

[Claim ~~19~~18] The air-cleaning device of claim ~~18~~17, wherein air flows into or out of the air-cleaning device in one direction.

[Claim ~~20~~19] The air-cleaning device of claim ~~18~~17, wherein a fan is installed in at least one of the air inlet region and the air outlet region.

[Claim ~~21~~20] The air-cleaning device of claim ~~18~~17, wherein the one or more catalyst structures for ozone decomposition comprises a~~t least one~~ plurality of catalyst structures.

[Claim ~~22~~21] An air-cleaning system comprising an air-cleaning device including one or more of the catalyst structures for ozone decomposition according to claim 1.