

Supporting Information

**Ethylene oxidation activity of silica-supported platinum catalysts for
the preservation of perishables**

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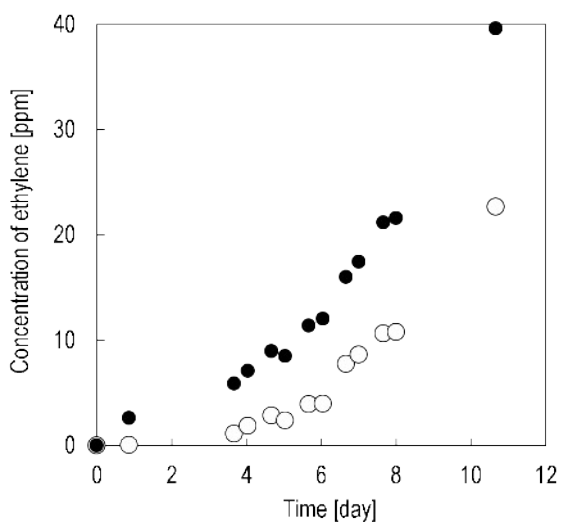


Figure S1. Time course for the ethylene concentration during storage tests of banana stored with PtRu/A380 (open circles) and without catalyst (closed circles) at 22 °C. Reaction conditions: catalyst PtRu/A380 10 g, banana 0.15 kg, desiccator 33 L (acrylic box).

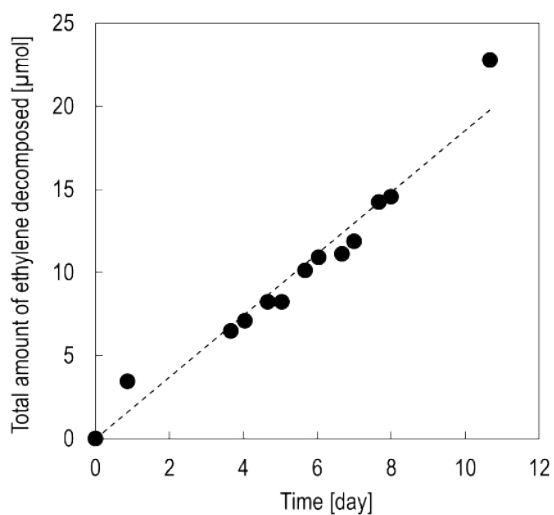


Figure S2. Total amount of ethylene decomposed by PtRu/A380 during storage test of banana stored with the catalyst at 22 °C. The dashed line shows a linear fitting. Reaction conditions: catalyst PtRu/A380 10 g, banana 0.15 kg, desiccator 33 L (acrylic box).

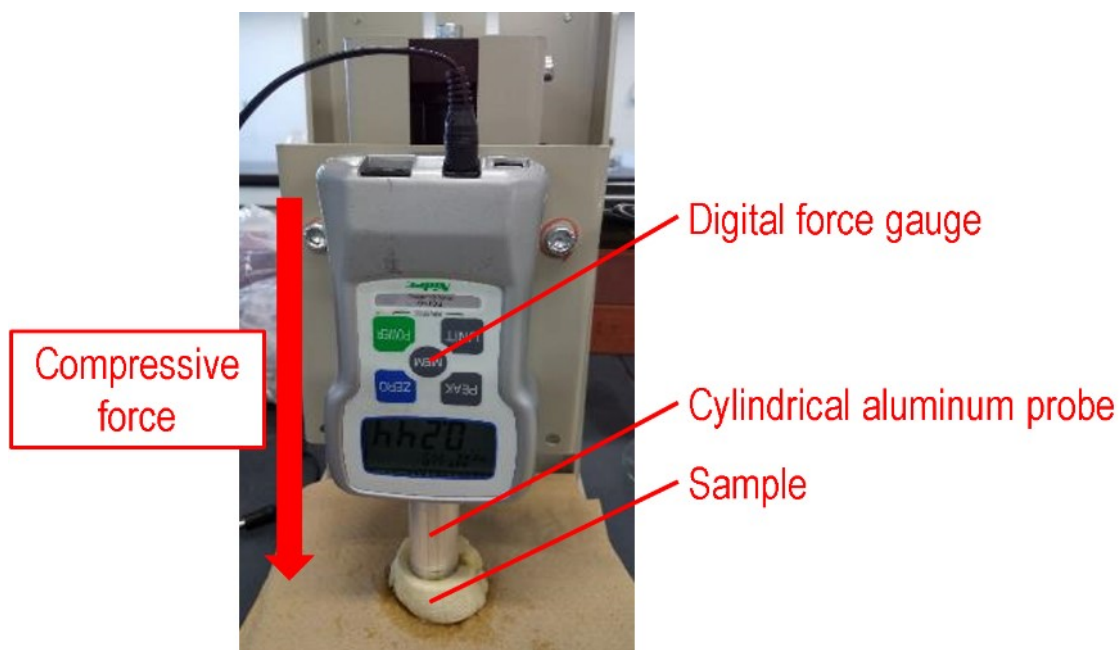


Figure S3. Apparatus for measurement of mechanical strengths of the premature bananas. The premature banana was cut into cylindrical samples with ca. 2 cm length. Compressive force was exerted on the top surface of the sample. The fracture strength is defined as the compressive force when displacement of the probe reaches 1.5 cm. The mechanical strength is calculated by dividing the fracture strength by the surface area of the probe (3.14 cm²).



Figure S4. A reaction system for test reaction using ethylene gas to measure ethylene oxidation activity of the catalysts. Reaction conditions: catalyst Pt/A380 7.0 g, initial concentration of ethylene 50 ppm, rotational speed 1,000 rpm, initial relative humidity 50%, desiccator 10.5 L.

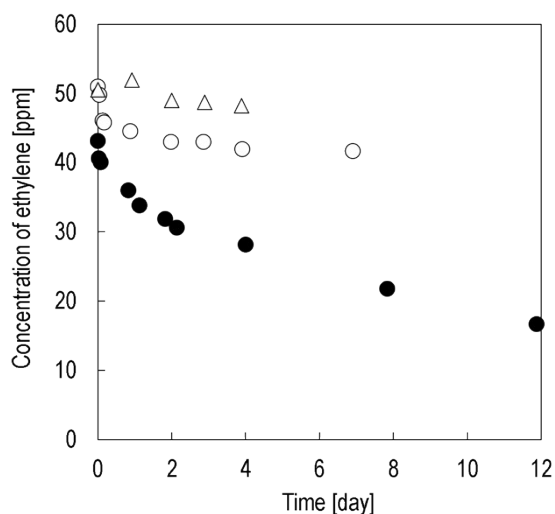


Figure S5. Time course for the ethylene concentration during the test reaction using ethylene gas at 25 °C; Pt/A380 (closed circles), A380 (open circles) and without any catalysts (open triangles). Reaction conditions: catalyst Pt/A380 7.0 g, initial concentration of ethylene 50 ppm, rotational speed 1,000 rpm, initial relative humidity 50%, desiccator 10.5 L.

In the test reaction using ethylene gas (Figure S5), 14 ppm of ethylene (50-36 ppm) is removed by 7.0 g of Pt/A380 through adsorption in initial one day. Based on this data, adsorption capacity q is estimated to be $21 \text{ mL}_{\text{C}_2\text{H}_4} \text{ kg}_{\text{cat}}^{-1}$ at ethylene concentration C of 36 ppm ($14 \times 10^{-6} \times 10.5 \times 10^3 \text{ mL}_{\text{C}_2\text{H}_4} / 7.0 \times 10^{-3} \text{ kg}$). Hypothesizing that q is proportional to C (Henry's isotherm), the Henry adsorption constant k is $0.58 \text{ mL}_{\text{C}_2\text{H}_4} \text{ kg}_{\text{cat}}^{-1} \text{ ppm}^{-1}$ ($q = kC$). In Figure 1, ethylene concentration of "with catalyst" was less than the detection limit of the sensor (0.15 ppm) throughout the test. Using this concentration (0.15 ppm) and k ($0.58 \text{ mL}_{\text{C}_2\text{H}_4} \text{ kg}_{\text{cat}}^{-1} \text{ ppm}^{-1}$), the maximum adsorption capacity q in Figure 1 is calculated to be $0.087 \text{ mL}_{\text{C}_2\text{H}_4} \text{ kg}_{\text{cat}}^{-1}$. Thus, the maximum adsorption volume is $0.087 \text{ mL}_{\text{C}_2\text{H}_4} \text{ kg}_{\text{cat}}^{-1} \times 0.007 \text{ kg}_{\text{cat}} = 0.61 \text{ } \mu\text{L}_{\text{C}_2\text{H}_4}$ and the maximum decrease in concentration is $0.61 \text{ } \mu\text{L}_{\text{C}_2\text{H}_4} / 10.5 \text{ L} = 0.06 \text{ ppm}$. This value is approximately 1/60 of the decrease in ethylene concentration removed during the test (3.5 ppm), and hence we conclude it is due to oxidation of ethylene by Pt/A380.

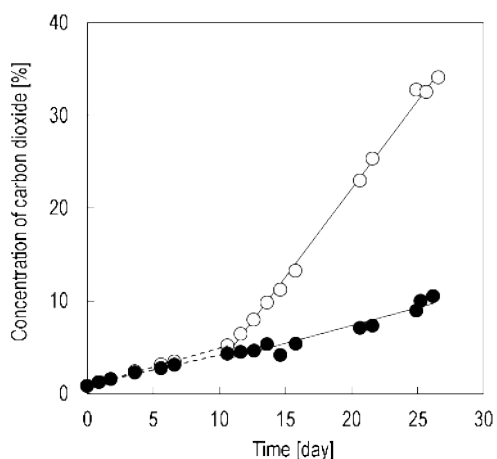


Figure S6. Time courses for the concentration of carbon dioxide during the storage tests for premature banana stored with Pt/A380 (closed circles) and without catalyst (open circles) at 13 °C. The dashed lines show linear fitting in the range of day 0-10 to calculate the respiration rate. The solid lines show linear fittings in the range of day 10 to day 27. Reaction conditions: catalyst Pt/A380 7.0 g, premature banana 0.20 kg, initial relative humidity 50%, desiccator 10.5 L.

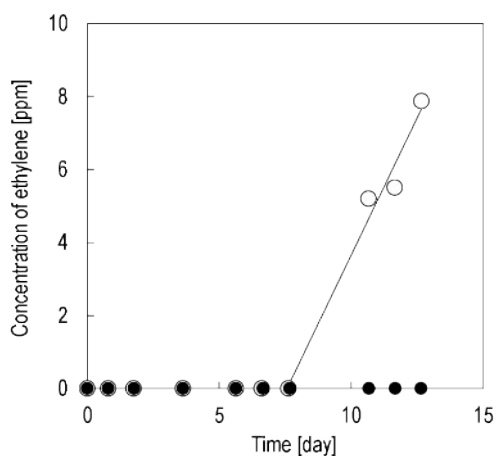


Figure S7. Time course for the ethylene concentration during the storage tests of premature banana stored with Pt/A380 (closed circles) and without catalyst (open circles) at 22 °C. The solid line shows the fitting in the range of day 8-13 to calculate the rate of the ethylene production r . Reaction conditions: catalyst Pt/A380 7.0 g, premature banana 0.20 kg, initial relative humidity 50%, desiccator 10.5 L.

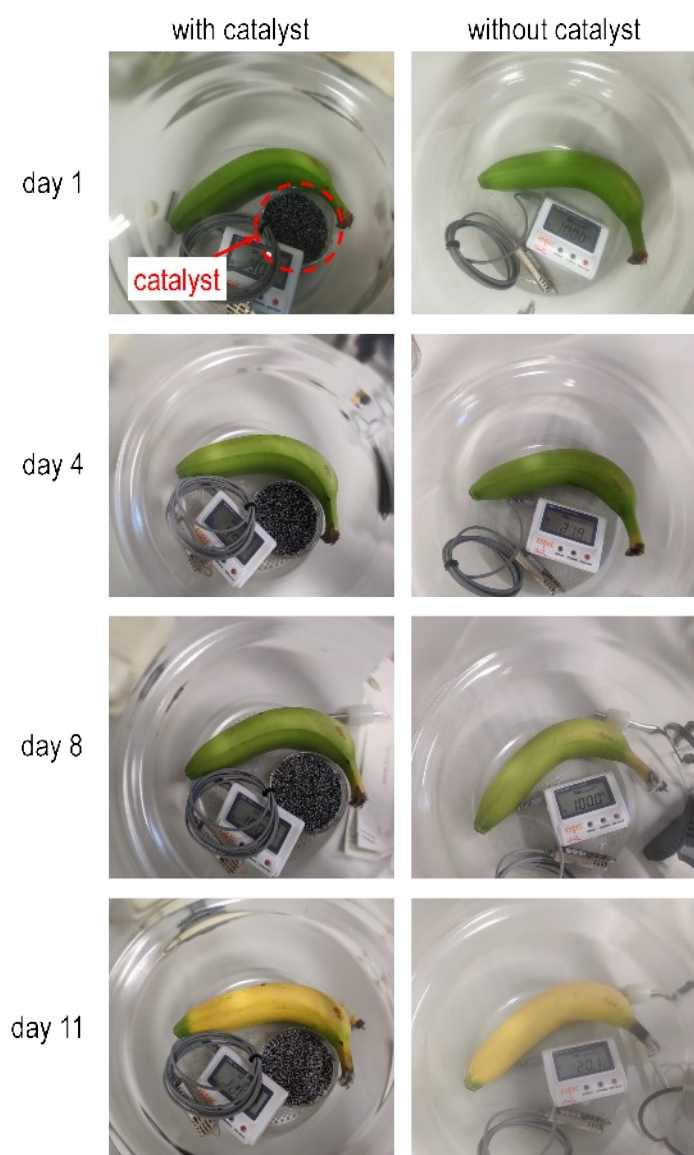


Figure S8. Photographs of a premature bananas stored with Pt/A380 (left column) and without any catalysts (right column) at 22 °C. Reaction conditions: catalyst Pt/A380 7.0 g, premature banana 0.20 kg, initial relative humidity 50%, desiccator 10.5 L.

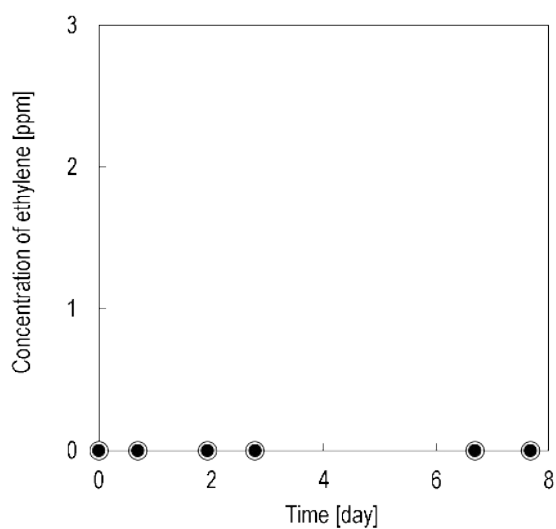


Figure S9. Time course for the ethylene concentration during storage tests of cucumbers stored with Pt/A380 (closed circles) and without any catalysts (open circles) at 10 °C. Reaction conditions: catalyst Pt/A380 7.0 g, cucumbers 0.30 kg, desiccator 10.5L.

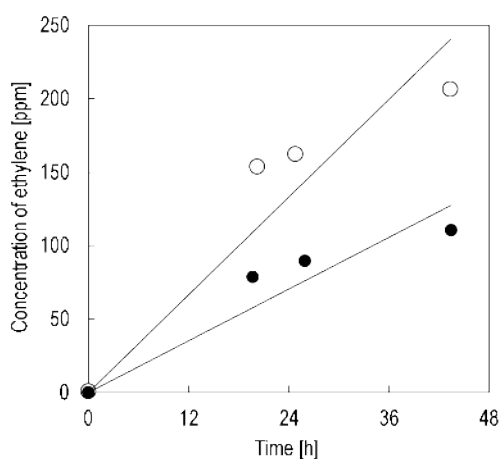


Figure S10. Time course for the ethylene concentration during the storage tests of apples stored with Pt/A380 (closed circles) and without any catalysts (open circles) at 25 °C. The solid lines show the fittings in the range of 0-48 h to calculate r and r^2 . Reaction conditions: catalyst Pt/A380 7.0 g, apple 0.21 kg, desiccator 10.5 L.

Derivation of Equation 3

The mass balance for ethylene around the storage room can be expressed as follows using Equation S1.

$$\begin{aligned} & \text{(The amount of ethylene accumulated in the storage room)} \\ & = \text{(the amount of ethylene produced from the perishables)} \\ & \quad - \text{(the amount of ethylene released from the room by ventilation)} \\ & \quad - \text{(the amount of ethylene decomposition by the catalyst)} \end{aligned} \quad (\text{S1})$$

Equation S1 can be expressed using the several parameters as shown in Equation S2. $C(t)$ is concentration of ethylene in the storage room at a time of t . V [m³] is the total volume of the storage room. F [$\mu\text{L}_{\text{C}_2\text{H}_4} \text{h}^{-1}$] is the volumetric flow rate of ethylene released from the room by ventilation. m_p [kg_{per}] and m_c [kg_{cat}] are the masses of the perishables and the catalyst, respectively. r [$\mu\text{L}_{\text{C}_2\text{H}_4} \text{h}^{-1} \text{kg}_{\text{per}}^{-1}$] is the rate of ethylene production from the perishable. R [$\mu\text{L}_{\text{C}_2\text{H}_4} \text{h}^{-1} \text{kg}_{\text{cat}}^{-1}$] is the rate of ethylene decomposition by catalyst. Δt is the time step for the numerical calculation using the forward Euler method.

$$\{C(t + \Delta t) + C(t)\} V = r m_p \Delta t - F C(t) \Delta t - R m_c \Delta t \quad (\text{S2})$$

By dividing both sides in Equation S2 by Δt and approaching Δt to 0, Equation S2 can be expressed as a differential form as shown in Equation S3, which is Equation 4 in the manuscript.

$$V \frac{dC(t)}{dt} = r m_p - F C(t) - R m_c \quad (\text{S3})$$