for a better future

KEP

Heat Resistance of PA66

R&D Center

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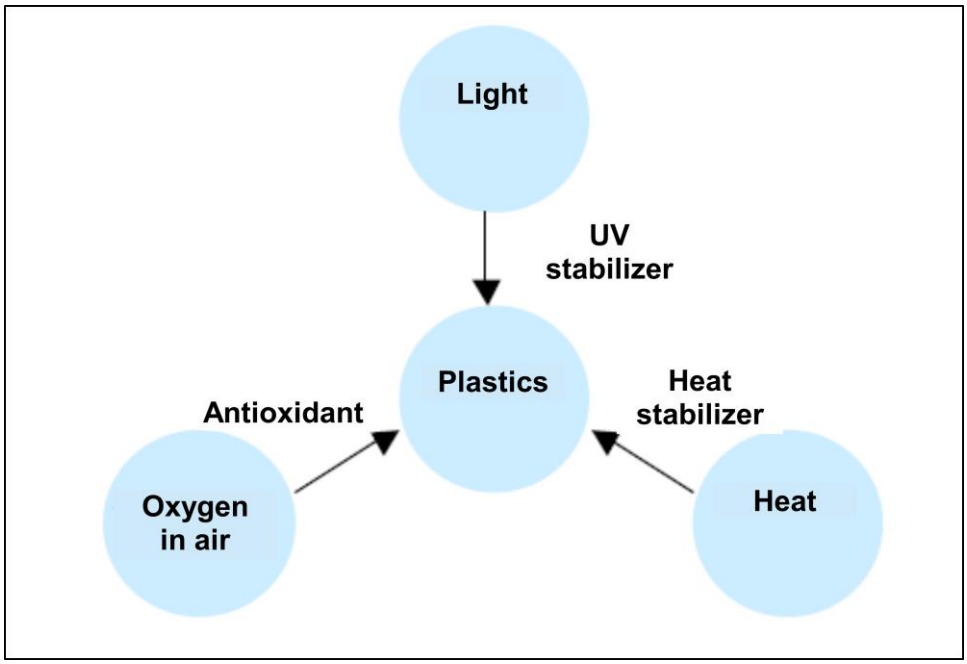
1. Summary

(1) The oxygen content of air is 20.9 % and most materials are easily oxidized when in contact with air.
(2) Polymer radicals are formed by heat or mechanical shear stress in extrusion and injection molding and peroxy radicals are rapidly formed by oxygen and residual metal components.
(3) Plastics become brittle or the MI of plastics decreases because of reaction of radicals. Also, the MI of plastics increases due to degradation rendering it hard to use.
(4) Polyamide has the issue of discoloration and strength degradation when used at high temperatures for prolonged periods.
(5) To solve these challenges, heat stabilizers (a type of inorganic inhibitor) and antioxidants are applied to polyamides.



<Figure 1. Plastics stabilizer>

2. Mechanism of Antioxidant

(1) Free radical reaction occurs when plastics decompose due to heat, oxygen, light, etc. Free radicals are atoms, molecules, or ions with unpaired electrons, and they are expressed as R·.
(2) Free radicals are in unstable and try to grab electrons from other molecules.
(3) Free radicals are continually formed by oxidation, and the properties of plastics (strength, molecular weight) decrease due to polymer chain degradation.
(4) Antioxidants prevent oxidation reactions. (Initiation, propagation reactions)

1) Initiation reaction (Initiated by light, oxygen, heat, catalyst, etc.)

$$RH \rightarrow R\cdot$$
$$ROOH \rightarrow RO\cdot + \cdot OH$$

2) Propagation reaction

$$R\cdot + O_2 \rightarrow ROO\cdot$$
$$RO\cdot + R'H \rightarrow ROH + R'\cdot$$
$$ROO\cdot + R'H \rightarrow ROOH + R'\cdot$$

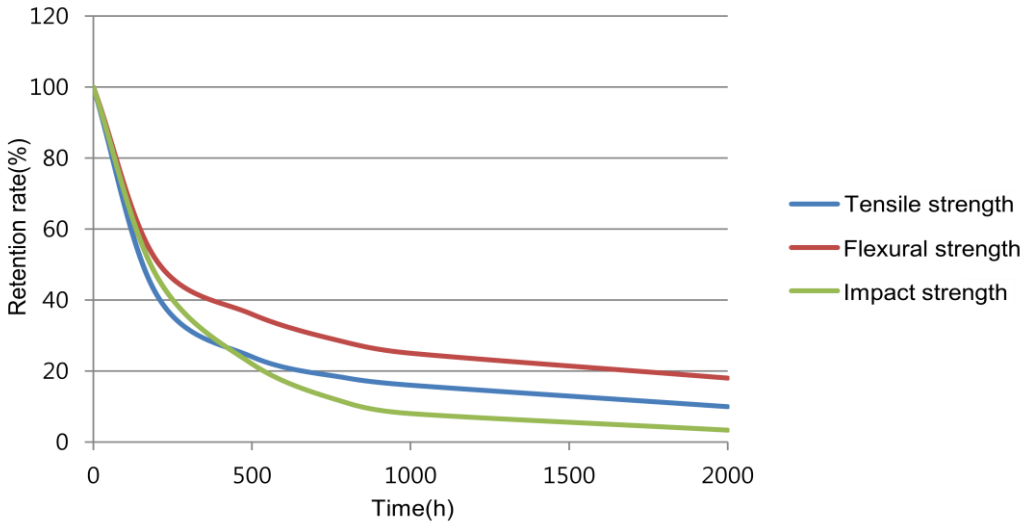
3. Heat Resistance of PA66

3.1. Summary

(1) Mechanical properties and surface properties of PA66 decrease because of polymer oxidation when in high temperature for prolonged periods. It differs according to the temperature, time, and size of a given specimen.
(2) The heat resistance of PA66 can be improved by adding antioxidants and heat stabilizers.

3.2. Heat resistance of PA66 unfilled grade

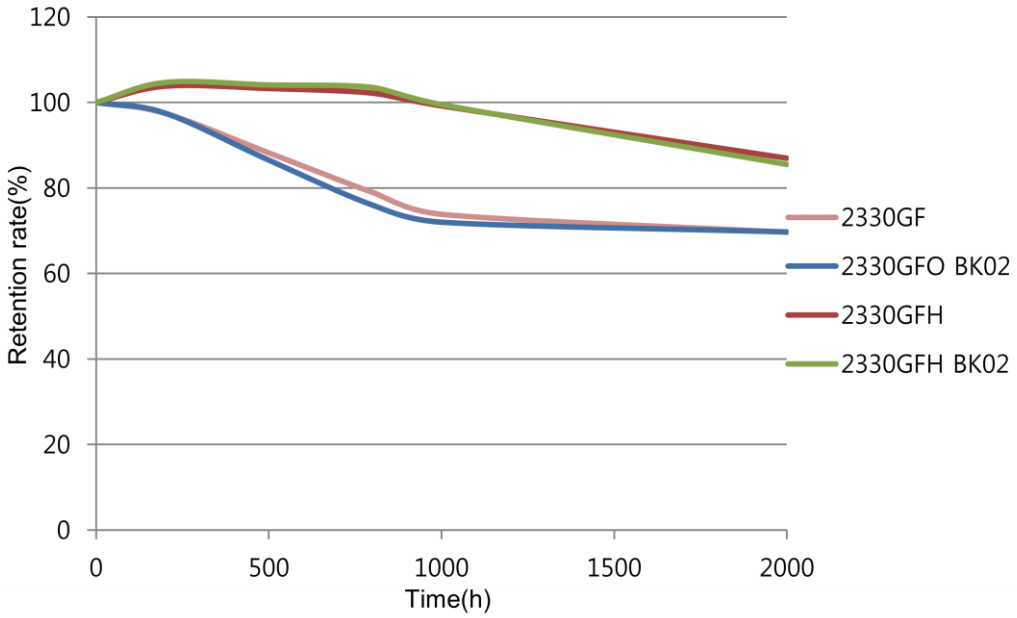
This graph displays the heat resistance (Retention rate of tensile, flexural, and impact strength of KEPAMID 2300MR, PA66 unfilled grade at 140 ℃. 2300MR grade doesn't contain heat stabilizers so its mechanical properties consistently decrease from the beginning of the test, retention rate of properties is under 50 % and it is about 10 % at 2000 h.



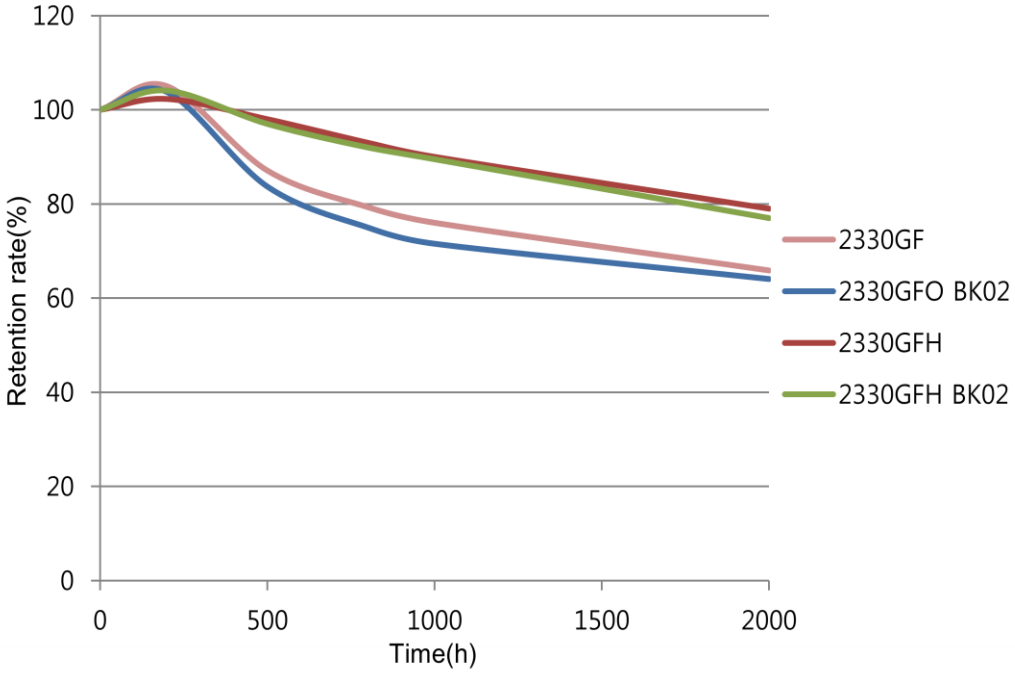
[Figure 2] Retention rates of strength of KEPAMID 2300MR at 140 ℃

3.3. Heat resistance of PA66 G/F-reinforced grades

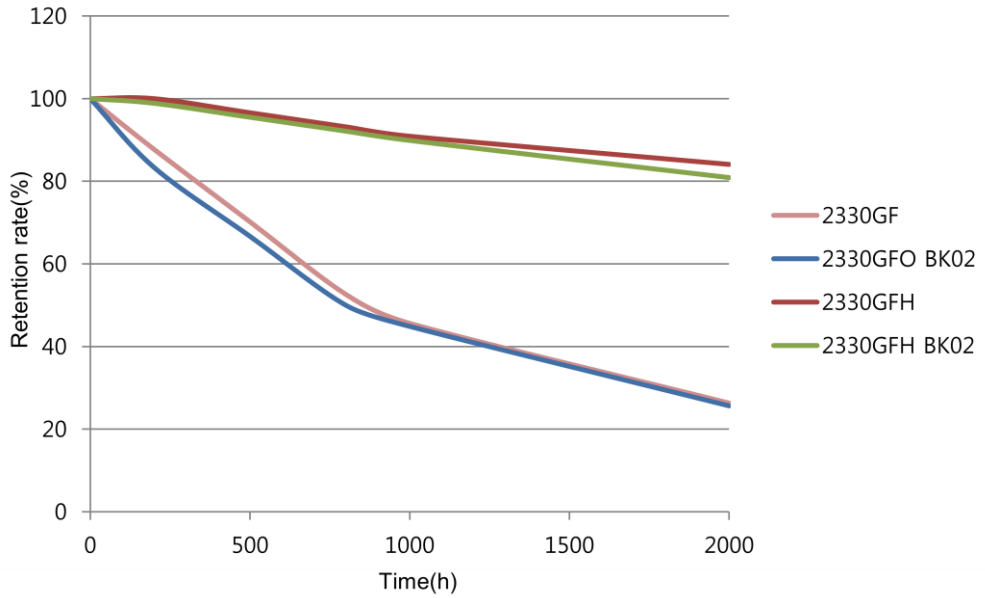
This figure shows the heat resistance (retention rate of tensile, flexural and impact strength) of PA66 glass fiber 30% reinforced grades, and KEPAMID 2330GF series at 140 ℃. 2330GF is a natural-colored product while 2330GFO BK02 is a black-colored product. Neither contains heat stabilizers. For heat stabilizers, both 2330GFH (natural-colored) and 2330GFK BK02 (black-colored) are suitable. You can see heat resistance grades that contain heat stabilizers have higher retention rates of strength, especially impact strength.



[Figure 3] Retention rates of tensile strength of KEPAMID 2330GF series at 140 ℃



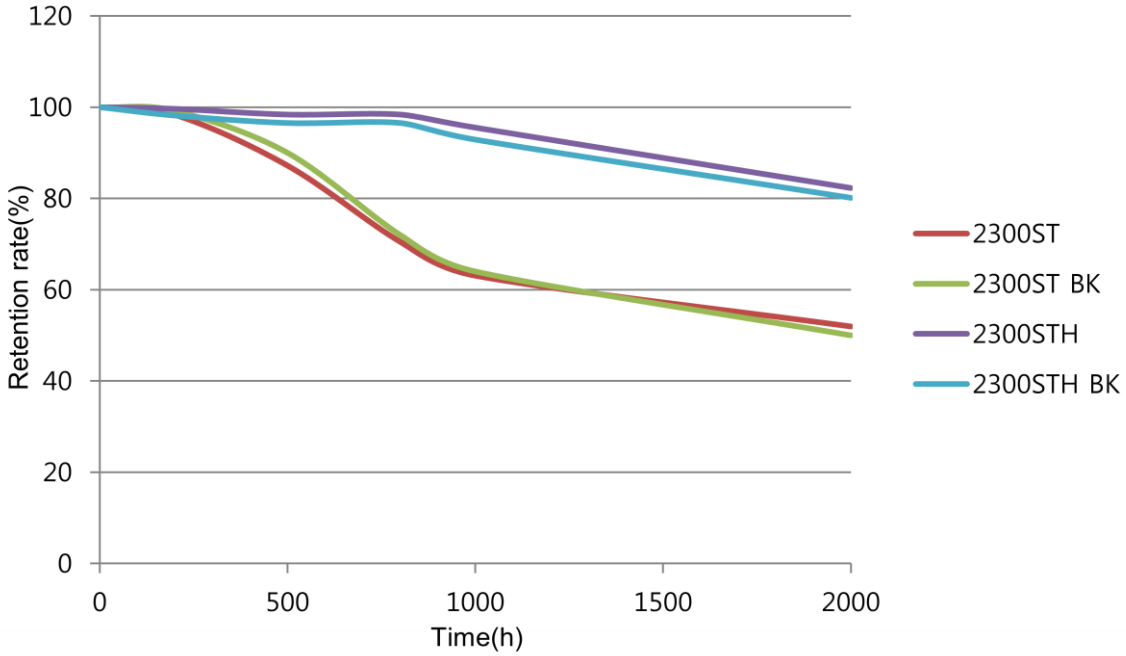
[Figure 4] Retention rates of flexural strength of KEPAMID 2330GF series at 140 ℃



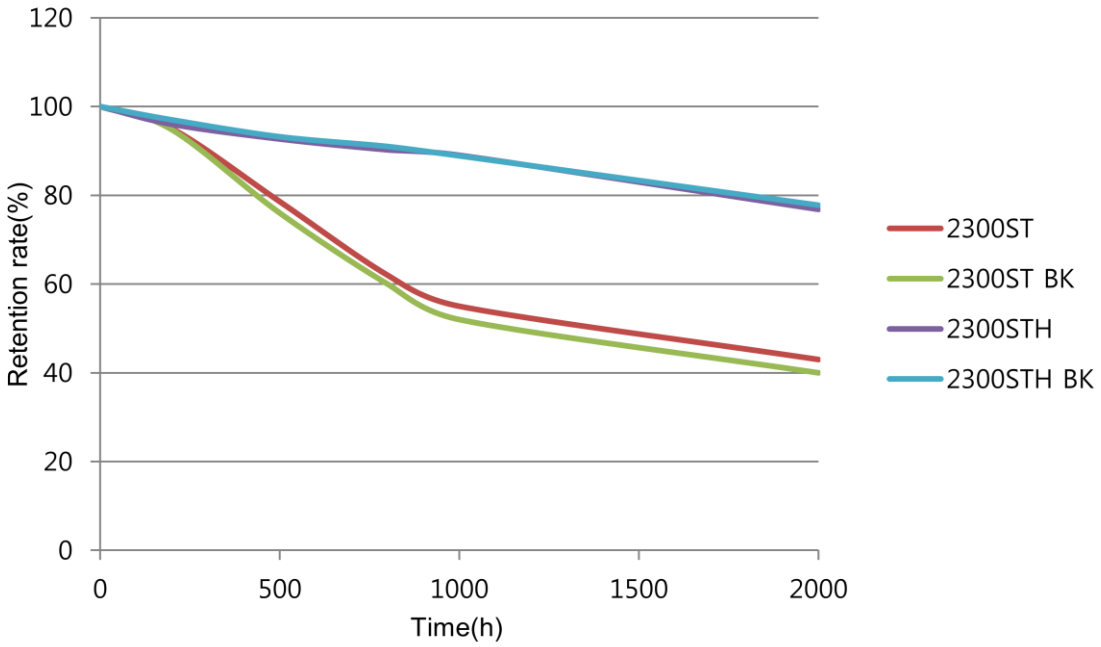
[Figure 5] Retention rates of impact strength of KEPAMID 2330GF series at 140 ℃

3.4. Heat resistance of PA66 impact modified grades

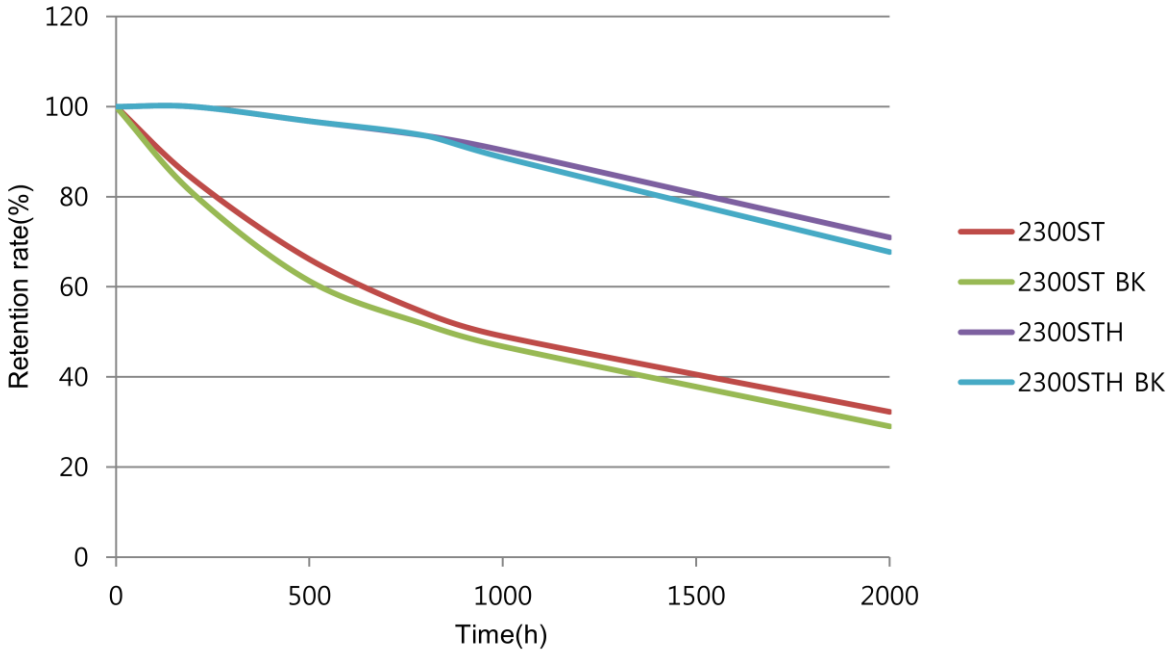
The following figures display the heat resistance (retention rate of tensile, flexural, and impact strength) of PA66 impact-modified grades, KEPAMID 2300ST series at 140 ℃. 2300ST is a natural-colored product while 2300ST BK is a black-colored product. Neither contains heat stabilizers. For heat stabilizers, both 2300STH (natural-colored) and 2300STH BK (black-colored) are suitable. You can see heat resistance grades that contain heat stabilizer have higher retention rates of strength, especially impact strength.



[Figure 6] Retention rates of tensile strength of KEPAMID 2300ST series at 140 ℃



[Figure 7] Retention rates of flexural strength of KEPAMID 2300ST series at 140 ℃



[Figure 8] Retention rates of impact strength of KEPAMID 2300ST series at 140 ℃

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