Long-life Molybdenum Mesh for Firing

1. Outline

In the firing process of magnets, ceramics, and other materials, many setter plates for firing, which are manufactured from molybdenum plates and rods, as well as heaters and reflectors for high-temperature furnaces are used.

To improve the quality of fired products, there is an increasing demand for molybdenum mesh (mesh material) for venting during firing and preventing the sticking of the setter plate to the fired products. This mesh material is fabricated using wires of 0.5 mm or less in diameter. This paper introduces "mesh with edge folded" and "mesh with improved resistance to breakage," both designed to address the problems of "fraying" and "breakage due to high-temperature use" observed in practical applications, as along with standard molybdenum mesh.

2. Features

2-1 Molybdenum mesh for firing

In the firing process of magnets and ceramics, molybdenum setter plates and firing jigs that exhibit low deformation even at high temperatures are used to suppress warping of the fired products. Technical requirements in the firing process include the release of gases emitted from the fired products and the prevention of sticking by reducing the contact area. We have proposed molybdenum and developed mesh (Fig. 1) to meet these needs.

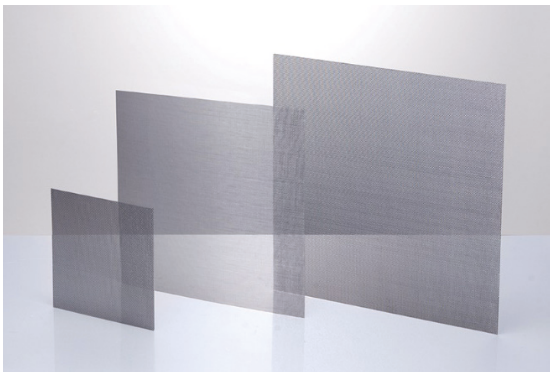

Fig. 1. Molybdenum mesh

Molybdenum mesh can be laid on the bottom of the fired product, placed between the fired products, or stacked as a spacer. A flatter surface is required to maintain in order to suppress the deterioration of dimensions caused by adhesion between the fired product and molybdenum, as well as the reduction in fired product quality due to poor gas venting.

Molybdenum mesh is made of molybdenum wire, woven in a weaving machine, formed into a strip, and then cut to the required size. The molybdenum wire diameter and mesh coarseness are used in different ways to achieve the required features, such as gas release and deformation resistance (Table 1).

Table 1. Examples of dimensions of molybdenum mesh

Type	MOS	MOP	TT-TEM
Purity (%)	≥ 99.95	≥ 99.95	≥ 99.00
Wire Diameter (mm)	φ0.12	φ0.35	φ0.5
Mesh	#50	#24	#16
Size (mm)	up to □400	up to □400	up to □400

2-2 Prolonged mesh life-1 Mesh with edge folded

One of the issues with molybdenum mesh usage is the potential for fraying at the outer periphery, depending on the usage environment. This fraying can cause abnormalities in the appearance of the fired product, and there is a risk of injury from the sharp tips.

To address this fraying, we devised a method to improve quality and service life by not only preventing fraying but also increasing the strength of the outer circumference by folding the edge[1] (Fig. 2).

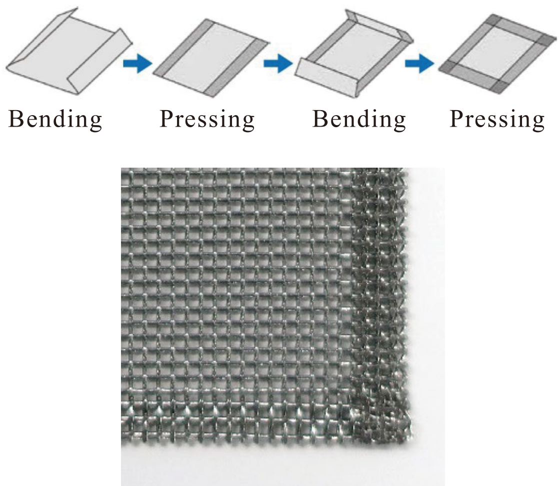

Fig. 2. Mesh with edge folded

To evaluate the deflective strength of this folded mesh, the load when the molybdenum mesh was deformed by 5 mm was measured and the resistance was compared. For evaluation, the molybdenum mesh was supported with a span of 100 mm, and the value when a load was applied in the center was measured with a force gauge (Fig. 3).

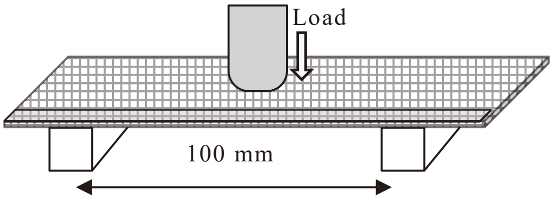

Fig. 3. Evaluation method of deflective strength

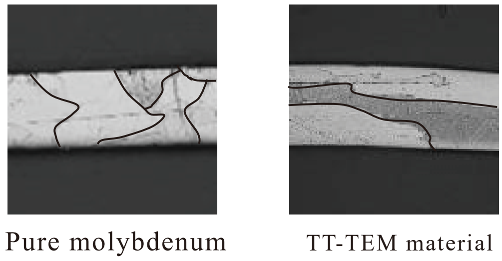

Fig. 5. Structure after heat treatment at 1800°C

As a result of the evaluation, the mesh without folds was deformed at 25.2 N, whereas the mesh with the outer circumference folded back withstood a load of 47.2 N. As a result, it was confirmed that the mesh could withstand approximately 1.9 times the load.

The molybdenum mesh was heated for 1 hour in a furnace at 1100°C simulating magnet firing and cooled 50 times, and the amount of deformation and change in appearance were evaluated. The molybdenum mesh without the folded part was deformed by 2.3 mm, and fraying and damage were observed, whereas the part with the folded part showed no breakage and deformation of 1.0 mm, indicating high temperature deformation resistance (Fig. 4).

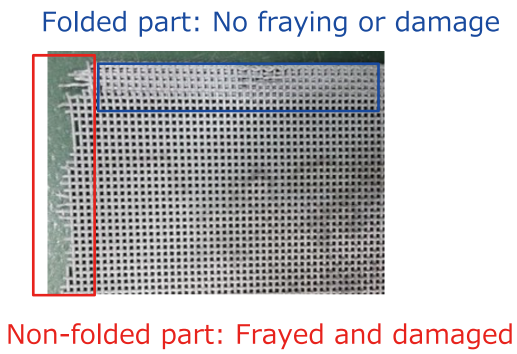

Fig. 4. Molybdenum mesh after use

2-3 Prolonged mesh life-2
Utilization of high temperature deformation resistant molybdenum material (TT-TEM)

When exposed to temperatures above 1000°C, molybdenum generally undergoes recrystallization, leading to a significant decrease in its creep properties at high temperatures and ductility at low temperatures. Molybdenum mesh also presents a similar risk of deformation and breakage with repeated use. Therefore, we have been developing the application of TT-TEM materials, which enhance creep resistance and low-temperature ductility, to the mesh. By controlling the structure of the recrystallized grains in TT-TEM materials, we have succeeded in improving resistance to high-temperature deformation and maintaining a level of ductility that allows for bending (Fig. 5). By subjecting this TT-TEM material mesh to bending processes, further improvements in deformation resistance and handling can be expected.

3. Conclusion

Tungsten and molybdenum are used as high-temperature materials. However, their weaknesses in high-temperature applications include deformation and breakage due to recrystallization. We have received feedback from our customers who manufacture magnets and ceramics indicating that they struggle with these issues. We feel that we were able to develop a very easy-to-use product that overcomes the weaknesses of conventional molybdenum by making full use of our proprietary materials and processing technologies. We hope to expand the use of molybdenum mesh in even more fields.

• TT-TEM is a trademark of A.L.M.T. Corp

Reference

(1) S. Watanabe, and Y. Itou, Molybdenum Mesh. Japan Patent7092835 (2022)