Joining of the Sinter Hardening Pully by Sinter Brazing

Chao-Hsu Cheng[1, a], Yi-Ching Lin[1,b], Yan-Cherng Lin[1,c] and Lih-Ren Hwang [1,d]

[1]Chung Chou Institute of Technology, Department of mechanical and computer-aided engineering
No.6, Lane 2, Sec. 3, Shanjiao Rd., Yuanlin Town, Changhua County 510, Taiwan (R.O.C.)
[a]chaohsu@dragon.ccut.edu.tw, [b]weili3344@yahoo.com.tw,
[c]ycline@dragon.ccut.edu.tw, [d]lrhwang@dragon.ccut.edu.tw

Abstract

This research mainly focuses on the development of sinter brazing technology for improving the process related to belt pulley made by sinter hardening. As the machine process of belt pulley takes up more than half of the total manufacturing hours, we propose changing the process to pulley groove brazed and bonded with pulley disc by applying sinter brazing to belt pulley. With the new process, the belt pulley is expected to reduce manufacturing cost to 70% of the original process by applying the sinter brazing technology; and the belt pulley bound by sinter brazing only loses 10% bonding strength compared with the original process.

Keywords : sinter brazing, sinter hardening, pulley

1. Introduction

This research is aimed at improving the manufacturing process of belt pulley made by powder metallurgy by applying sinter brazing. As the powder metallurgy materials are porous materials, the decision on whether or not to use brazing fillers and the sinter brazing conditions (temperature, atmosphere) will influence the brazing bonding quality. The permeability of brazing fillers in the sintering metal have been extensively investigated, and numerous reports have been published relating to finding a way to overcome the problem related to the absorption of brazing fillers by the sintering metal[1]. Among these literature[2-4], there have been reports related to expositions focusing on the sinter brazing filler designs of powder metallurgy materials, chemical compositions, and the application of special brazing bonding between porous sinters.

Belt pulley units are assembled by pulley disc and belt groove as shown in Fig. 1(a). The main purposes of the new process can be summarized as follows: (1) reduce the belt pulley units wear resistance to ensure the operation life; (2) create bonding force of the pulley disc that combines belt groove to ensure the driving belt does not swerve during the operation, and (3) cost down. Therefore, in this research, we evaluated the requirements of this belt pulley unit that manufacturing by sinter hardening, which doesn't require carburizing heat treatment after being sintered, to promote the accuracy and wear resistance of the belt pulley and ensure the brazability between the belt groove and pulley disc by sinter brazing.

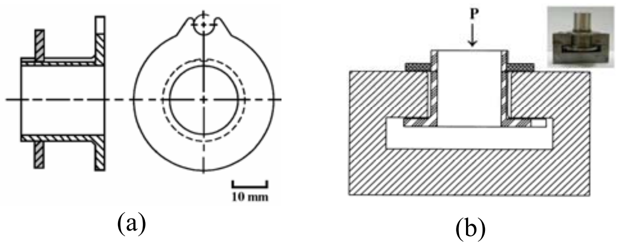

Fig. 1. Schematic illustration of (a) belt pulley; (b) bon-ding force tester of belt pulley.

2. Experimental and Results

One kind of basic steel powders used in this experiment is the pre-alloyed steel powders. The pre-alloyed powder contains 2.1% nickel, and 1.0% molybdenum alloying elements, which greatly enhance powder hardenability. Sinter hardening is the pre-alloyed steel powders admixed with 1.0% Ni, 2.0% Cu, 0.9% graphite, and 0.8 % Zn-St (MPIF standard FLC2-4808). The specimens, both pulley disc and belt groove, were pressed to a green density of 6.8 g/cm^3, and then sinter brazed in an endothermic atmosphere at 1120 °C for 30min. The furnace was equipped with a gas-quenching zone in the cooling section, assuring that a minimum cooling rate of 0.8 °C/sec was achieved. In this research, we took into consideration four commercial fillers to investigate the bonding characters of sinter brazing. The fillers are numbered A, B, C, and D, which composition as shown in Table 1.

Joint strength was measured by the Computer Servo Control Materials Testing Machines after the belt pulley units were sintered and brazed to evaluate the brazability of difference fillers with belt pulley units. The molding equipment for measuring the joint strength of belt pulley units is shown as Fig. 1(b). The bonding force test results of belt pulleys made by different brazing fillers are listed in Table 1.

Table 1. Bonding force of brazing joint of belt pulley units by difference brazing fillers.

Fillers composition	Bonding force $_{max}$	Rupture deformation
A ($Cu_{90}P_{10}$)	307 Kgf	0.658 mm
B (Pure Cu)	40 Kgf	0.406 mm
C ($Ni_{45}Cr_{40}Mn_{15}$)	6,547 Kgf	1.514 mm
D ($Ni_{85}Cr_{10}Cu_{5}$)	198 Kgf	1.284 mm

Brazed joint of belt pulley units. Sinter hardening powder was used and pressed to make the pulley disc and belt groove body. The four brazing fillers was separately placed in the bonding interface of the belt pulley units, and sinter brazing was conducted for 30 minutes at 1120℃.

The bonding strength of belt pulley units were used to measure the molding equipment after sintering and bonding, and the computer servo control materials testing machines were used to detect the bonding strength of belt pulley units to evaluate the influence of different brazing fillers on the bonding force of belt pulley units in the process of sinter brazing.

As shown in Fig. 2, the bonding force of the belt pulley units using filler C is 6,547 Kgf, which shows that the brazability of filler C is much better than other fillers (filler A: 307 Kgf, filler B: 40 Kgf, filler D: 198 Kgf).

Bonding force of belt pulley. The belt pulleys were originally manufacturing by turning process. Then, the required hardness of the belt pulley was realized by heat treatment.

The proposed sinter brazing process forms pulley discs and belt grooves separately by sinter hardening, then, bonds these two parts made by powder metallurgy during the sintering process by sinter brazing to simplify the process as well as the engineering of turning process and heat treatment to ultimately promote the added value of products.

The bonding force of belt pulley units of filler C sinter brazing, that was compared with the original manufacturing mode to evaluate the feasibility of massively producing belt pulley units by sinter brazing. The measurement result is shown in Fig. 3. Fig. 3(a) shows how belt pulleys were made by the original process with the rupture force of 7,256Kgf and Fig. 3(b) shows how belt pulley units were made by sinter brazing with the bonding force of 6,547 Kgf.

Through the new process, the belt pulley reduces the manufacturing cost to 70% of the original process by applying sinter brazing skill; and the belt pulley bonded by sinter brazing only loses about 10% bonding force when compared with the original process. This means that sinter brazing can be used to mass produce belt pulleys by sinter brazing.

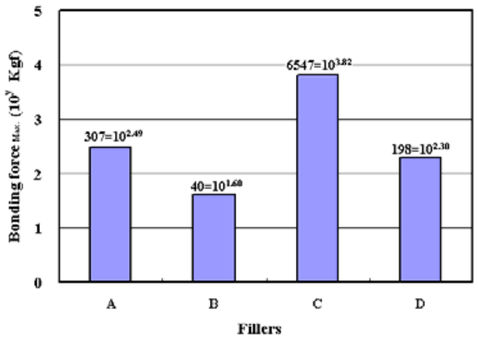

Fig. 2. Effects of brazing fillers on bonding force$_{Max.}$ of belt pulley units.

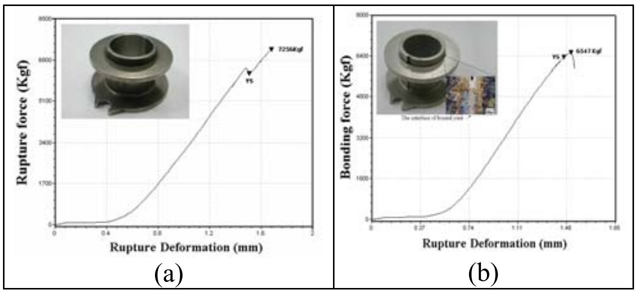

Fig. 3. Making belt pulleys by (a) the machine process (the rupture force: 7,256 Kgf), (b) the sinter brazing process (bonding force: 6,547 Kgf).

3. Summary

Observe the four brazing fillers in the sinter brazing test of belt pulley units, the bonding strength of filler C performs better than other fillers, and the bonding strength of filler C is 4-4.5 times stronger than the bonding strength of filler A or filler D.

The belt pulley reduces the manufacturing cost to 70% of the original process by applying sinter brazing technology; and the belt pulley bonded by sinter brazing only loses about 10% bonding force compared with the original process.

4. References

1. ONODA, M; KAMEDA, R; KOISO, T. Metal Powder Report. Vol. 38, no. 11, pp. 632-634. Nov. 1983.
2. Gabrielov; C. Wilson; J A. Hamill Jr. International Journal of Powder Metallurgy. Vol. 37, no. 7, pp. 46-48. Oct. 2001.
3. Capus, J M. Metal Powder Report. Vol. 57, no. 5, pp. 16-18. May 2002.
4. Lawley, Alan; Murphy, Thomas F. Materials Characterization Volume: 51, Issue: 5, pp. 315-327. December, 2003.