

## Adhesives and Sealants Used in Machinery and Equipment Assembly, Maintain and Repair

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### ABSTRACT

In this paper, some idea about the use of Metal and ceramic filled epoxy adhesive, Anaerobic adhesive and RTV silicone in the assembly, maintain and repair of machinery and equipment is given. Many examples which have been successfully used in Chinese industry are introduced:

• **Wear, Abrasion, Corrosion/Erosion Resistance and Metal Rebuilding**

Worn shafts, Scored Hydraulic Ram, Bearing Housings, Slurry Pumps (Bodies & Impellers), Slide-ways, Heat Exchangers, Cracked Castings and Molds, Leaking Pipes and Tanks.

• **Locking and Retaining**

Thread, Bearing, Keyways, Bolts, Nuts, Studs, Gears, Collars, Motors.

• **Sealing and Gasketing**

Flanges, Pipe Joints, Machined surfaces.

### INTRODUCTION

There are many kinds of machinery and equipment, such as machine tool, power machinery, elevator machinery, metallurgical machinery, chemical machinery, mining machinery, coal machinery, agricultural machinery, textile machinery, printing machinery, building and road-building machinery etc., even automobile vehicle, airplane, train and ship can also be called transportation machinery in broad sense. A modern machine is generally composed of 6 parts: (1) power part (engine or motor), (2) transmission part (shaft, gear, belt etc).

(3) join part (thread, nuts, keyway etc). (4) control part (electrical control, hydraulic pressure control etc). (5) working part (such as the tools in machine tool equipment, the conveyor belt in conveyor machine etc). (6) auxiliary part (cooling system, lubrication system etc).

Adhesives and Sealants are widely used in the above 6 parts of machinery and equipment, not only used in repair and maintain scored, eroded, worn machine parts, but also used in sealing, locking, gasketing and retaining machine parts in order to anti-loose and leaking.

Machine parts are usually made of metal,

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supporting friction, vibration and heat, so high mechanical strength and durability adhesives and sealants, such as epoxy, polyurethane, anaerobic adhesive, RTV silicone, cyanoacrylate, second generation acrylic adhesive etc. are needed in machinery and equipment assembly, maintain and repair. Sum up our experience, adhesives and sealants used in machinery and equipment assembly, maintain and repair are list in table 1(classify according to adhesives) and table 2(classify according to machine parts).

Adhesives and sealants are widely used in machinery equipment assembly, maintain and repair, we cannot list it all here, below are some typical examples.

## ANTI-FRICTION MATERIALS FILLED EPOXY USED FOR MAKING COATED SLIDE-WAYS

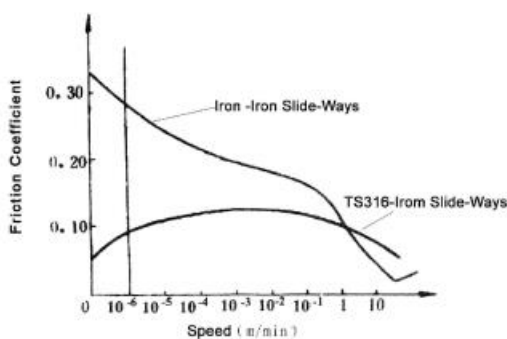
Traditional slide-ways is made of metal (cast iron-cast iron slide-ways), even if it is lubricated, the friction coefficient is high, the friction property curve of cast iron-cast iron slide-ways is shown negative oblique rate (Figure 1), when the working platform is speed up, the resistance is reduce, so it result in the platform 'creep', it influence the accurate of machining parts. Another, if lubrication is stopped, cast iron-cast iron

**Table 1. Adhesives and Sealants Used in Machinery Equipment Assembly, Maintain and Repair(Classify according to adhesives)**

Adhesives and sealants	Application for
Epoxy and metal (ceramic) filled epoxy	Structure bonding, repair and rebuilding bearing housings, worn and scored shafts, scored hydraulic rams, keyways, slide-ways, worn pump body and impeller, cracked casting, blow hole, leaking pipe and tank etc.
Anaerobic adhesive	Thread locking and sealing, ball bearing assembly, key and key way fitting, pipe sealing, cylindrical parts retaining and gasketing, penetrate and sealing cracks and weld porosities etc.
Oil resistance RTV silicone	Automobile flange sealing, oil pan and transmission cover seals, as well as T-joints and axle covers, coolant system and engine block seals etc.
Second generation acrylic adhesive	Structure bonding, stop up leaking pipe and tank etc.
Cyanoacrlate instant adhesive	Making O-Ring, manufacturing assembly operation etc.
Polyurethane adhesive	To repair rubber equipment, such as conveyor belts, to line equipment to protect wear due to abrasion and impact, such as hoppers, chutes, pump impellers, feeder bowl and fans and making molds forming dies etc.
Chloroprene rubber adhesive	Bonding conveyor belt joints, bonding rubber to metal.
Copper-phosphate adhesive	Bonding cutting tool bit, bonding broken shaft etc.

**Table 2. Adhesives and Sealants Used in Machinery Equipment Assembly, Maintain and Repair(Classify according to machine parts)**

Machine parts	Application
Engine	Anaerobic adhesive used for cam shaft bearing cover sealing, cylindrical parts retaining, bowl type plug and art hole retaining, thread locking. RTV silicone used for T-joints and axle covers, coolant system and engine block seals etc. Metal filled epoxy used for repair body casting defect, such as blow hole and crack etc.
Transmission system	Metal filled epoxy used for rebuilding bearing housing, worn and scored shaft, key ways, casting defects. Anaerobic adhesive used for Thread locking and sealing, ball bearing assembly, key and key way fitting, pipe sealing, cylindrical parts retaining and gasketing etc.
Pipe, pump and valves	Ceramic filled epoxy used for coat, repair to protect worn, eroded, corroded surfaces, such as, slurry pumps, wear plates, elbows, deflector plates etc.
Fans and air compress machine	Ceramic filled epoxy used for repair worn, eroded fan impeller. Metal filled epoxy used for rebuilding bearing housing, worn and scored shaft, key ways, casting defects. Anaerobic adhesive used for Thread locking and sealing, ball bearing assembly, key and key way fitting, pipe sealing and gasketing etc.
Heat exchanger	Ceramic filled epoxy used for repair eroded board and cover etc.
Conveyor belts	Polyurethane used for repair worn, scored conveyor belts on-site, chloroprene rubber adhesive used for bonding conveyor belt joints on-site etc.
Slide-ways and hydraulic ram	Anti-friction materials filled epoxy used for making coated slide-ways, repair and rebuilding worn, scored slide ways and hydraulic ram etc.

**Figure 1. The property curve of friction.**

slide-ways can easily 'bite' together, it result in slide-ways scored, above are the disadvantages of cast iron-cast iron slide-ways.

We have studied on anti-friction materials

filled epoxy coated slide-ways since late 1980', the anti-friction fillers are graphite, Molybdenum disulfide, polytetrafluoroethylene etc., one slide is made of cast iron, another slide coated with anti-friction materials filled epoxy, it is a best way to solve slide-ways especially heavy machine tool slide-ways 'creep' problem, and the coat can rebuilding when it is worn or scored.

Figure 1 shows the friction property curve of cast iron-cast iron slide-ways and TS316 coat-cast iron slide-ways, cast iron-cast iron slide-ways is shown negative oblique rate in 0-10 m/min, speed range, TS316 coat-cast iron slide-ways is also shown negative oblique rate, but it is much smaller, so TS316 coat-cast iron slide-ways

can avoid slide-ways 'creep', and it consume 30~50% lower work power than cast iron-cast iron slide-ways.

TS316 coat-cast iron slide-ways have successfully used on ZKD6300 vertical lathe, X2150 heavy plane miller in the heavy machine tool plant of DEYANG and in machine tool plant of BEIJING. The process to coat the slide which using anti-friction materials filled epoxy is 'shape copy' method (Figure 2), first, mixing anti-friction materials filled epoxy TS316, then coated it on one slide surface, another slide surface spray release agent, then put two slide together, curing about 24 h at room temperature, remove the slide away, the coated slide is finished.

The anti-friction materials filled epoxy coat-cast iron slide-ways has many advantages: (1) Because it has low friction coefficient, about 0.04~0.07, so it can avoid heavy machine tool slide-ways 'creep'. (2) If there are some casting defects in the slide surface, such as blow holes, the coat can fill it, avoiding the slide worthless. (3) The coat can be rebuilding when it is worn or scored. (4) It consume lower work power (30~50%) than cast iron-cast iron slide-ways.

## METAL FILLED EPOXY USED ON MACHINE PARTS REBUILDING

Metal filled epoxy also called polymer-metals. It can be put on the surface of the parts in any shape, the processing is easy, rapid, safe, economic and time saving. This material takes the metallic particles and fibers as the backbone (Figure 3), showing its excellent mechanical properties, high bond strength to all metals, high compressive and tensile strength and high wear

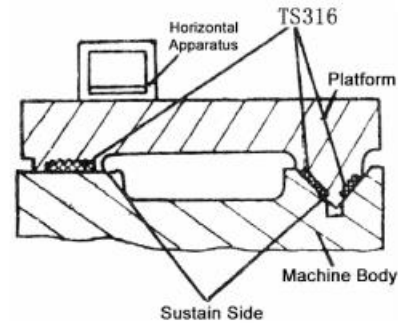


Figure 2. TS316 used on machine tool slide-ways.

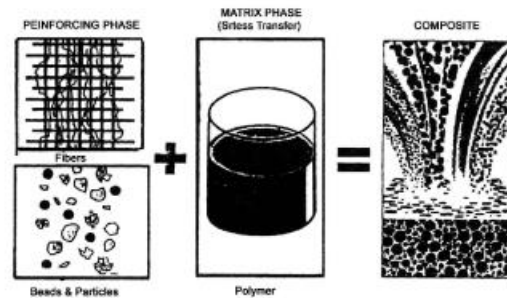


Figure 3. The composition of polymer-metal.

resistance. After being cured, it seems to be the metallic one and can be machined by turning, milling, drilling and grinding. It can be used widely for repairing the machine part to improve their wear resistance and corrosion resistance, for preventive coating and for mending various defects on the machine parts, such as cracks, scratches, dimension error and casting defects etc., Figure 4 shows some typical examples.

## CERAMIC FILLED EPOXY USED ON SLURRY PUMP

Ceramic filled epoxy also called polymer-ceramics, It takes the ceramic particles and beads as the backbone (reinforcing phase), the epoxy adhesive as the bonding agent (matrix phase), showing its excellent mechanical properties, high bond strength to

all metals, high compressive and high wear resistance. The mechanism of the composite as below:

Properties

Ceramic backbone + Epoxy polymer matrix = Polymer-Ceramics composite

<i>Wear resistance:</i>	<i>excellent</i>	<i>not good</i>	<i>excellent</i>
<i>Impact strength:</i>	<i>bad</i>	<i>good</i>	<i>good</i>
<i>Shaped:</i>	<i>not easy</i>	<i>shaped easy</i>	<i>shaped easy</i>
<i>Adhesion:</i>	<i>no</i>	<i>excellent</i>	<i>excellent</i>
<i>Heat resistance:</i>	<i>excellent</i>	<i>middle</i>	<i>middle</i>

According to this principle, we have designed TS218 Polymer-ceramics composite, its wear resistance is 2~8 times to the steel, it has successfully used on slurry pump rebuilding in JIUJIANG chemical works in 1994, as Figure 5.

### ANAEROBIC ADHESIVE USED FOR ENGINE ASSEMBLY

Anaerobic adhesives are an economical, reliable alternative to mechanical fasteners and seals, the anti-loose effect of anaerobic adhesive is better than traditional mechanical ways, Figure 6 shows that when time is gone, the shaft direction strength of the thread which used anaerobic adhesive

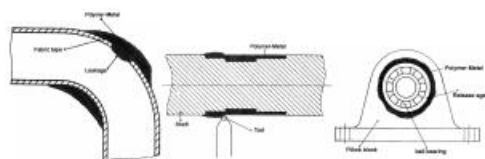


Figure 4. Polymer-Metals used on machine parts Rebuilding.

is not reduce, but the traditional ways, like nuts with nylon ring, standard nuts, spring ring, nuts adding nylon particles, are all reduced rapidly. With just a drop of adhesive, assembled parts are sealed against vibration, shock, and chemical leakage. Metal parts sealed with anaerobic adhesive stay tight until disassembled with hand tools. In engine assembly (Figure 7), anaerobic adhesives used for cam shaft bearing cover sealing, cylindrical parts retaining, bowl type plug and art hole retaining, thread locking, gasketing etc.

### OIL RESISTANCE RTV SILICONE USED ON AUTOMOBILE SEALING

Oil resistant RTV silicone is a one part nonslumping, acetoxime-cure, rubber that is suitable for numerous formed-in-place sealing and gasketing application. It is

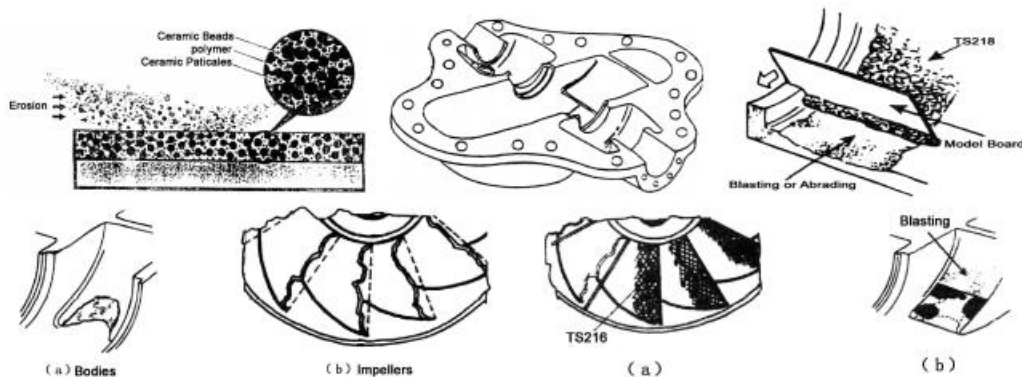
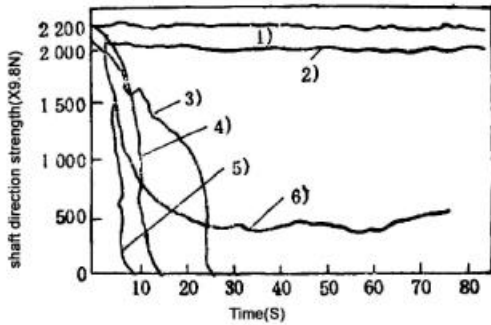
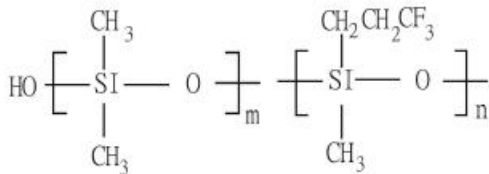


Figure 5. Polymer-ceramics used on slurry pumps.



**Figure 6.** The anti-loose effect of anaerobic adhesive and mechanical ways : 1) Anaerobic adhesive, 2) Raised side nuts, 3) Nuts with nylon ring, 4) standard nuts, 5) Spring ring, 6) Nuts adding nylon particles.

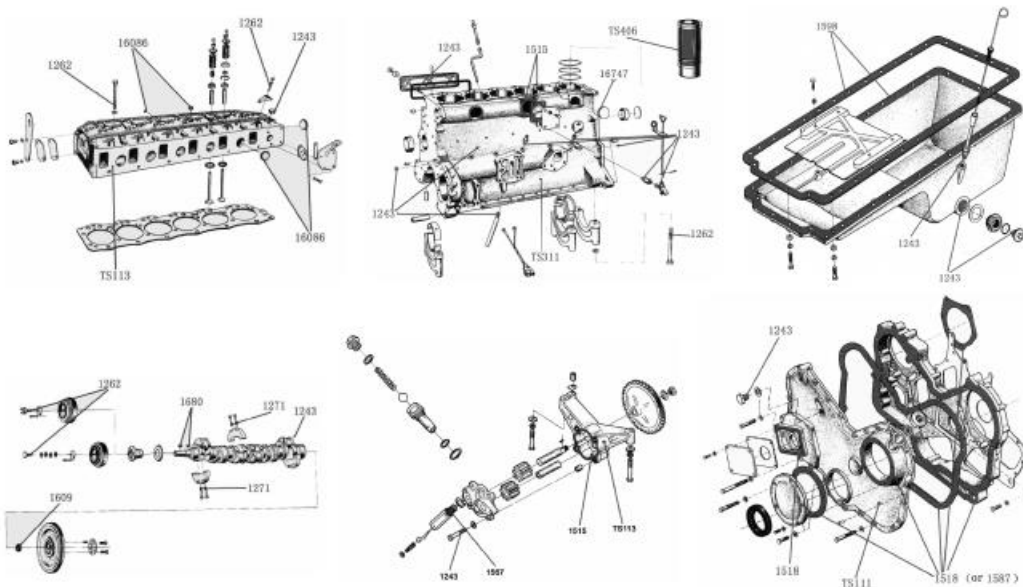
deferent from the RTV silicone which used in building window glass sealing, the base material in oil resistance silicone is as below:



Because there is  $-\text{CF}_3$  in the polymer structure, the cured silicone rubber is resistant to many common oils, coolants, and lubricants. The product has good thermal resistance, fast cure rates, and excellent mechanical properties. It can be used for many automobile flange sealing applications. Because of its high viscosity, the sealant is recommended in applications where immediate pressure leak testing is required. Typical applications include oil pan and axle cover seals, as well as coolants system seals and engine block main seals (Figure 7). Our products such as 1587 have successfully used on the automobile industry such as BEIJING general internal combustion plant, SHANGHAI Transmission box plant etc.

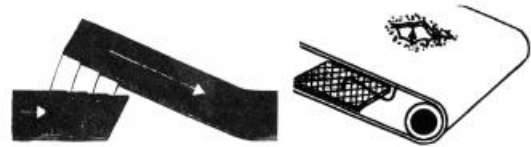
## POLYURETHANE ADHESIVE AND CHLOROPRENE RUBBER ADHESIVE USED FOR CONVEYOR BELT BONDING AND REPAIR

Polyurethane and chloroprene adhesives



**Figure 7.** Anaerobic adhesives & RTV silicones used on engine assembling.

are flexible adhesive, polyurethane used for repair worn, scored conveyor belts on-site, chloroprene rubber adhesive used for bonding conveyor belt joints on-site etc. (Figure 8).



**Figure 8. PU & CR used on conveyor belt.**

## CONCLUSIONS

Adhesives and sealants are widely used in machinery equipment assembly, maintain and repair:

(1) Simplicity in use, no special tools and equipments needed, bonding or repair can be carried out on-site.

(2) Versatility in application, not only used in repair and maintain scored, eroded, worn machine parts, but also used in sealing, locking, gasketing and retaining machine parts in order to anti-loose and leaking.

(3) Machine life in longer, metal (ceramic) filled epoxy used for repair and rebuilding cracked, worn, scored, eroded, corroded machine parts, made it live longer, cost effective, reduce the need for spare parts, keep machine moving.

(4) Reliability in machine moving, anaerobic adhesives and RTV silicone used for machine parts locking, sealing, retaining and gasketing, it has more reliability than the traditional ways, such as paper or

rubber washer, set-screws, locknuts, and cotter pins etc. Once the parts are mated, they formed a unitized assembly that resists vibration. In addition, the mated parts are sealed against attack from corrosion, internal rust, seizure, solvents, lubricants, gases, and other chemicals.

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