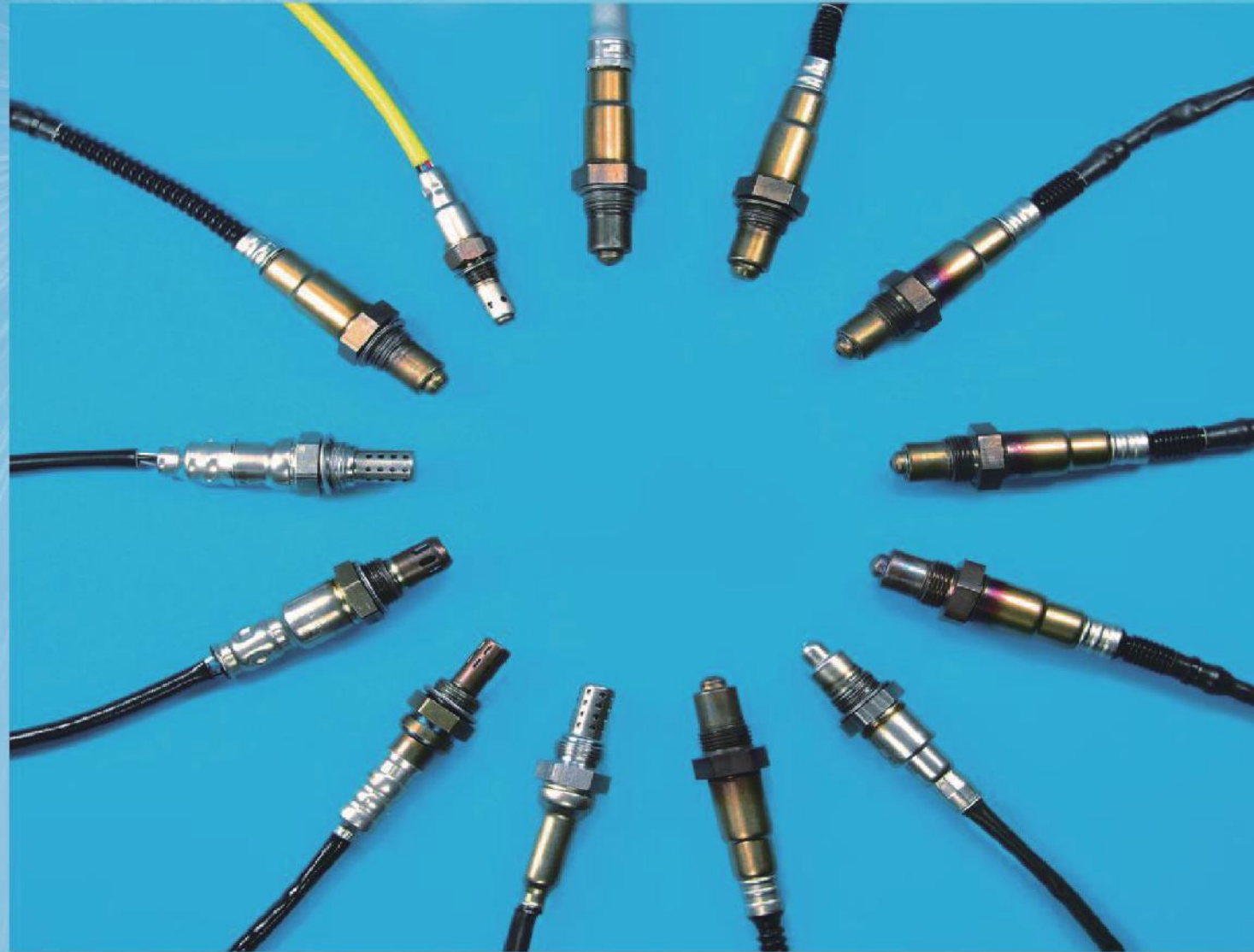


# OXYGEN SENSOR

Professional Production Base  
of Oxygen Sensor for Automobiles





# COMPANY INTRODUCTION

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TAKUMI AUTO PARTS CO., LIMITED





Since 1970s , Takumi Group started its industrial ceramic business from a small factory. Afterwards Takumi's spirit of innovation and industriousness was drawing attention of Toyota. Following the demand of Toyota, Takumi has been contributing to the development and research of electrical and electronic system such as spark plugs, igniton coils and sensors. Before 2013, Takumi Group was mainly serving Japan automotive industry as premium product supplier. In Japan, the "Takumi" concept is a kind of craftsmanship, which represents full devotion, meticulous attention to details, and excellence; having a true belief in excellence, achieving excellence at all espects.

After 2013 , premium product demand from China made it possible to have manufacturing facilities in China and reach balance of performance and cost.

Major milestones are in next slide.



# ADVANCED EQUIPMENT

## & QUALITY ASSURANCE

### Equipment for Oxygen Sensor Element

We worked with specialized manufacturers and developed the first automatic production line of oxygen sensor elements and assemblies in China. Our tape caster is automatic and has precise control over the casted tape; automatic punching machines equipped with servo motor system, and has high precision, reliability, and fast response speed; fully automatic printing and drying line makes the whole process operated by manipulator possible, including tape feed, alignment, printing, inspection and drying, and can be traced by 2-D barcodes; for the production of oxygen sensor elements, there is whole process barcode tracing and records of each process in place to trace quality and records of the whole process.

The developed assembly line is equipped with 1kW continuous laser welder. The whole assembly process, including press riveting, welding, packaging and wire harness connecting, and in-process inspection, such as air-tightness & atmosphere testing, are carried out continuously.





## Oxygen Sensor Assembly & Testing Equipment



We have a product inspection and testing & engineering center, which is equipped with self-developed rich fuel voltage tester, on-off tester, burning stimulating tester, rich fuel & lean fuel alternating tester etc., for sampling and full inspection of oxygen sensor product. There is also Universal Material Tester and electrical testing equipment, which further ensures product reliability, stability and uniformity.

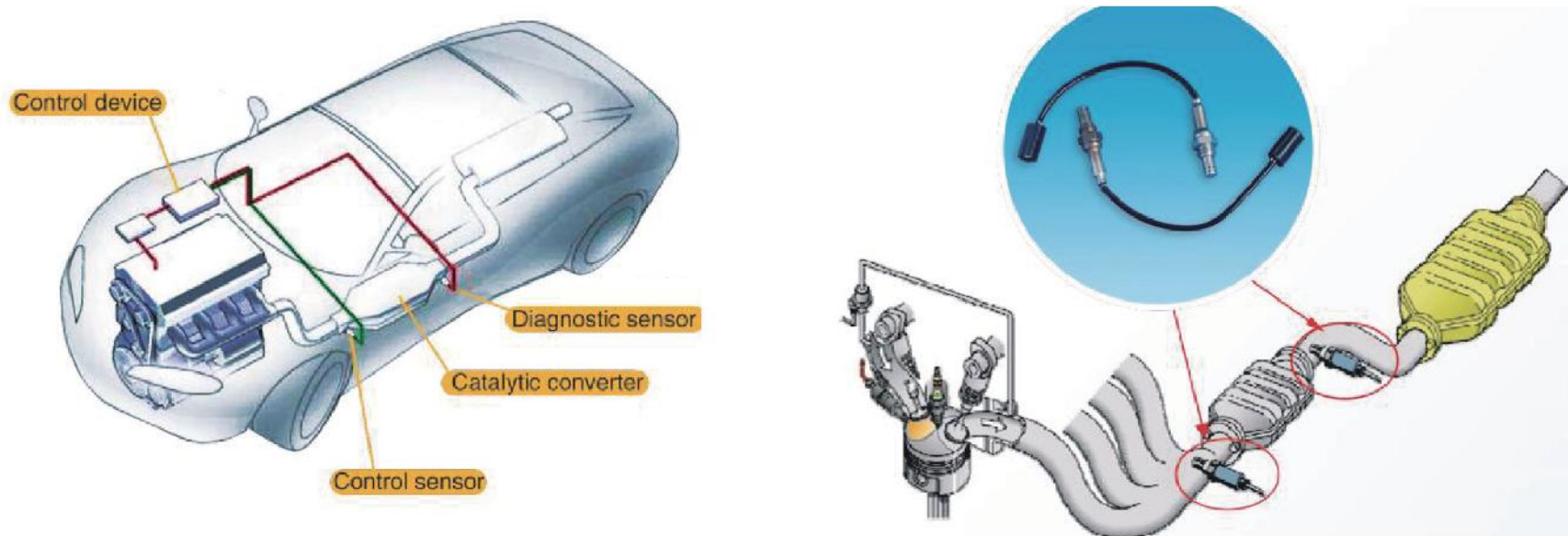


## Introduction of Planar Heated Oxygen Sensor for Automobiles

Function and operating principle of planar heated oxygen sensor for automobiles

### Function

Oxygen sensor is the major sensor component in electronic fuel injection engine control system, and is the key part to control automobile exhaust emission, reduce pollution to the environment and improve fuel combustion quality of automotive engine. Oxygen sensor is used in the feedback control system of the electronic control fuel injection device, to detect the concentration of oxygen in the exhaust gas and whether the air fuel ratio is lean or rich. It is also used to monitor theoretical air fuel ratio (14.7:1) combustion in the engine, and provide feedback signals to the computer.

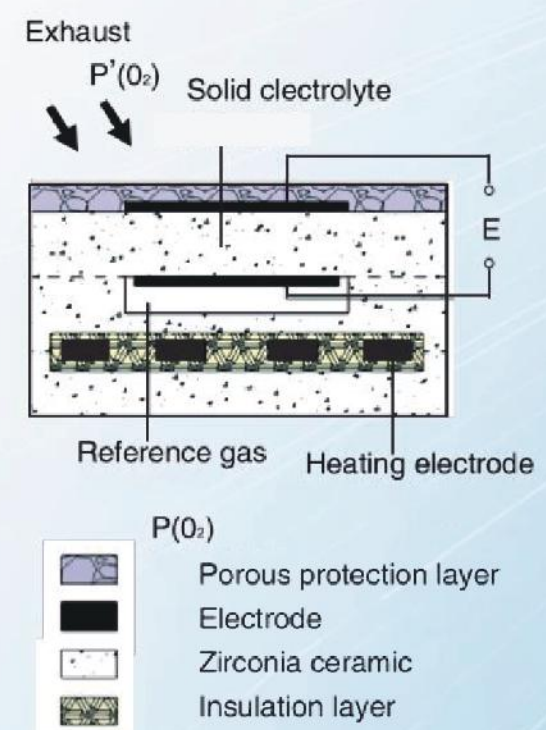


### Operating principle

The principle for concentration cell type oxygen sensor is that the difference of the Exhaust oxygen partial pressure of the two  $ZrO_2$  solid electrolytes provides concentration potential. It uses the characteristics of  $ZrO_2$  with oxygen ion conduction and no electron conduction at high temperature. Nernst formula can be used to obtain the concentration potential value:

$$E = \frac{RT}{4F} \ln \left( \frac{p(O_2)}{p'(O_2)} \right)$$

"R" in the formula is the ideal gas constant; "T" is the absolute temperature of the sensing element; "F" is faraday constant; " $p(O_2)$ " is the oxygen partial pressure of the exhaust side; " $p(O_2)$ " is the oxygen partial pressure in air. Thus, at a certain temperature, if the reference gas is the air (ie., the reference oxygen partial pressure is known), the E value can be determined by the oxygen content of exhaust. A high voltage (0.6 ~ 1V) is generated between the electrodes when the oxygen concentration is low on the exhaust side of the substrate, and the voltage signal is sent to the ECU and amplified. The ECU processes high voltage signal as a rich mixture, and low voltage signal (about 0.1V) is considered as a dilute mixture. Based on the voltage signal feedback of the oxygen sensor, the computer will dilute or enrich mixture accordingly to reach optimal theoretical air fuel ratio.



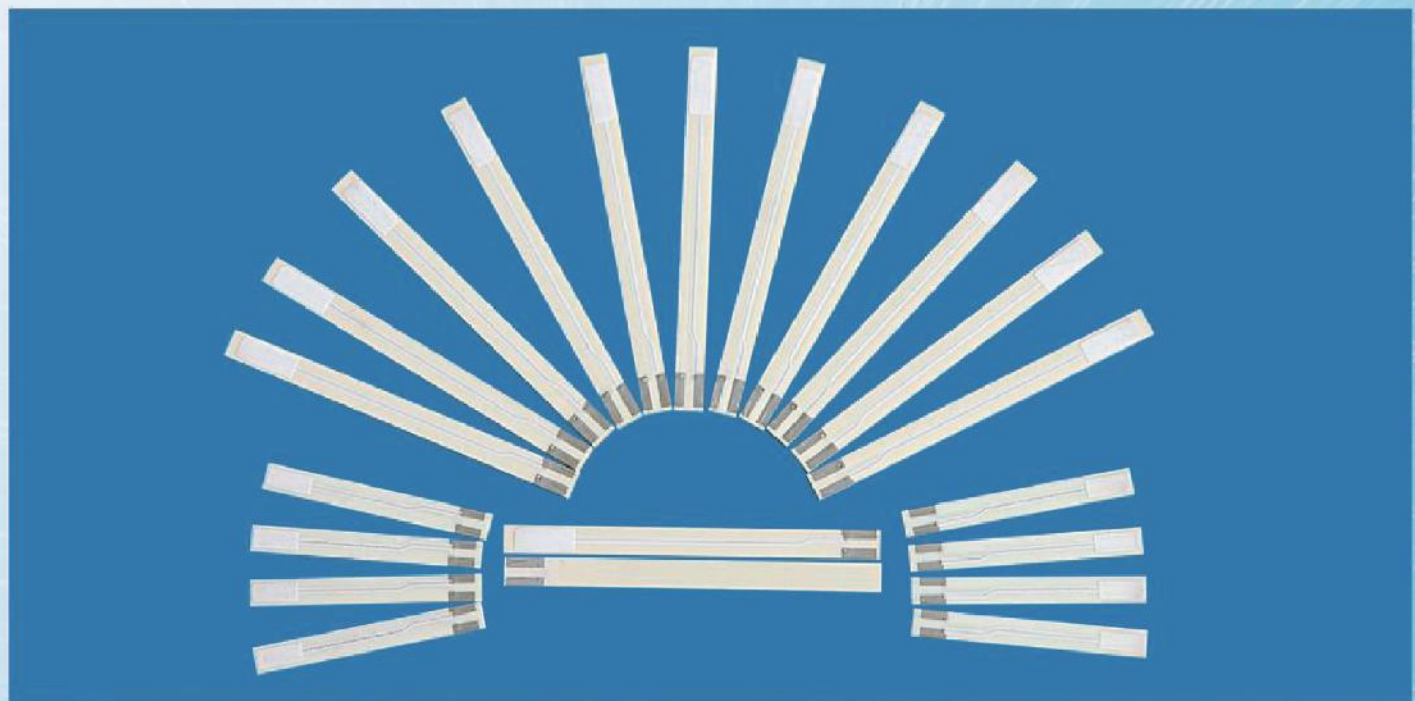


# COMPANY

>> > PRODUCT

## Automotive Oxygen Sensor Element Series

Planar Heated Oxygen Sensor Element for Automobiles



### Performance indicators:

Table 1 Performance of oxygen sensor element

Item	Exhaust temperature	
	350°C	850°C
Voltage between positive and negative signal electrodes(mV) $\lambda = 0.93 - 0.97$	$\geq 750$	$\geq 650$
Voltage between positive and negative signal electrodes(mV) $\lambda = 1.05 - 1.10$	$50 \pm 30$	$50 \pm 30$
Internal resistance( K $\Omega$ )	$\leq 1.0$	$\leq 0.5$
Response Time ( ms )	600mV-300mV	<150
	300mV-600mV	<100
Light-off time(s)	<15	<15

### Normal Specification:

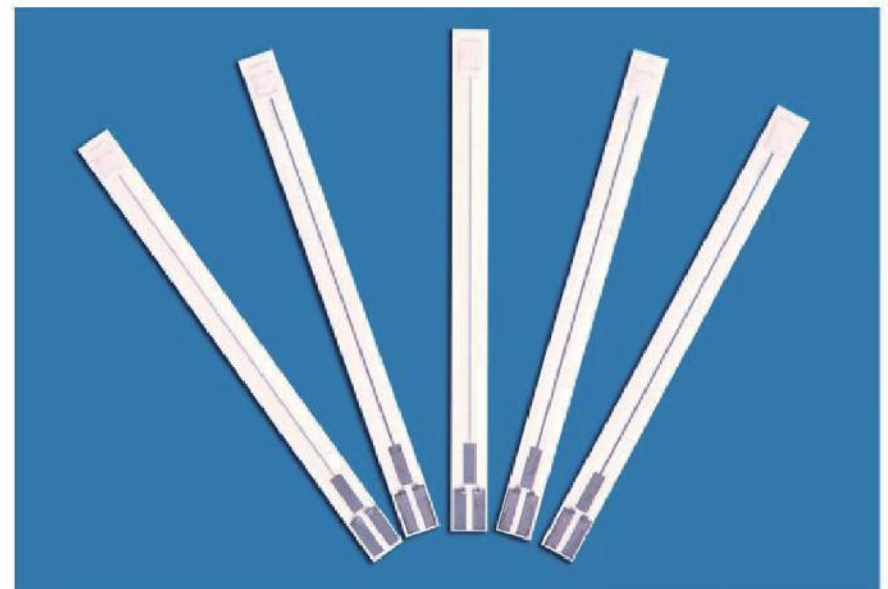
Model	Resistance ( $\Omega$ )	Working Voltage (V)	Length (mm)	Width (mm)	Thickness (mm)
Long	$9 \pm 1$	12~13.5	$59.5 \pm 0.5$	$4.35 \pm 0.1$	$1.35 \pm 0.5$
Short	$8 \pm 1$	12~13.5	$53.5 \pm 0.5$	$4.35 \pm 0.1$	$1.35 \pm 0.5$
Motorcycle	$10 \pm 1$	12~13.5	$35.5 \pm 0.5$	$4.3 \pm 0.1$	$1.35 \pm 0.5$



## Wideband Oxygen Sensor Element

### Typical properties:

- a) Dimensions : length (mm) × width (mm) × thickness (mm) =  $(59.5 \pm 0.5) \times (4.35 \pm 0.1) \times (1.35 \pm 0.05)$
- b) Bending strength (MPa)  $\geq 380$
- c) Insulation between heater and electrode (M $\Omega$ )  $\geq 30$  M $\Omega$
- d) Heater resistance:  $3.2 \pm 0.5 \Omega$



### Operating temperature range:

Table 1 Operating temperature range of oxygen sensor element

Position in the element	Min. working temperature	Min. storage temperature	Max. working temperature	Max. storage temperature
Induction area	350	-40	1030	90
Electrode area	-		90	

### 3 Performance test:

#### 3.1 Performance indicators

Table 2 Performance of wideband oxygen sensor element

Model	LSU4.2	LSU 4.9
Heating steady state power ( W )	10	7.5
Nernst cell internal resistance ( $\Omega$ )	80	300
Lambda measuring accuracy (0.8)	$0.8 \pm 0.03$	$0.8 \pm 0.03$
$I_p=0$ , Lambda measuring accuracy	$1.01 \pm 0.003$	$1.01 \pm 0.003$
Lambda measuring accuracy (1.7)	$1.7 \pm 0.05$	$1.7 \pm 0.05$
Lambda measuring range	0.65~air	0.65~air



## Automotive Oxygen Sensor Series

### 1. Oxygen Sensor for European Car Brands

Our product can be applied to the following European car brands: Mercedes-Benz, BMW, Volkswagen, Audi, Opel, Land Rover, Lotus, MG, Citroen, Peugeot, Skoda, Spyker, Seat, Fiat, Iveco, Lancia and Alfa Romeo etc.

Typical models include: POLO, Golf, Jetta, Bora, Lavida, Sagitar, Santana, Peugeot 206, Peugeot 207, Peugeot 408, Picasso, C-Quatre etc.



### 2. Oxygen Sensor for US Car Brands

Our product can be applied to the following US car brands: Buick, Dodge, Ford, GMS, Hummer, Jeep, Cadillac, Chrysler and Chevrolet etc.

Typical models include: Excelle, Excelle GT, Regal, Lacross, Park Avenue, Focus, Mondeo, Captiva, Sail, Aveo, Cruze etc.





### 3.Oxygen Sensor for Korean Car Brands

Our product can be applied to the following Korean car brands:Hyundai, Kia and Ssangyong etc.

Typical models include: Chollima, Soul, Cerato, Forte, Sportage,Carnival, K3, K4, K5, Sonata, Verna, Elantra and new Tucson etc.



### 4.Oxygen Sensor for Japanese Car Brands

Our product can be applied to the following Japanese car brands:Toyota, Nissan, Honda, Subaru, Mazda, Mitsubishi, Isuzu, Suzuki and Daihatsu etc.

Typical models include: Accord, Spiorior, Civic, CIIMO, Fit, Nissan Teana, Sylphy, Tida, Livina, Vios, Mazda, Yaris and City etc.





## 5. Automotive Wideband Oxygen Sensor

Our product can be applied to the following European and US car brands which meet China V Emission Standard: Mercedes-Benz, BMW, Volkswagen, Audi, Ford, Cadillac and Chevrolet etc.

Typical models include: Audi A4, Audi A4L, Audi A5, Audi A6, BMW 5 series, BMW 7 series, Viano, Vito, Mercedes-Benz B-Class, Mercedes-Benz E-Class, New Santana, Wrangler and Liberty etc.



LSU4.2



LSU4.9

## 6. Motorcycle Oxygen Sensor

Our product can be applied to the following EFI motorcycle brands: Honda, Benelli, Kawasaki, Suzuki Haojue, CFMOTO, Dayun, Dayang, Regal Raptor, Qianjiang, Jialing and Yamaha etc.







**TAKUMI AUTO PARTS CO., LIMITED**