

Method using full release

When the specimen is allowed to be destroyed, a strain gauge is bonded on the measurement position and whole circumference of the position is cut to fully release the residual stress. The residual stress is calculated by stress analysis using the change of strain resulted from the cutting.

Residual stress measurement using cutting method

Strain gauge to be used is selected from single-axis gauge, 2-axis gauge, 3-axis gauge and stress concentration measurement gauge according to the condition.

Also in the full release method, care must be taken not to allow any strain by machining is induced and not to damage the strain gauge during the cutting.

As the cutting method, cutting grinder with a thin cutter or electrical discharge machining is utilized. These methods cause little machining stress.

Generally, measurement is made using a data logger (static strain meter).

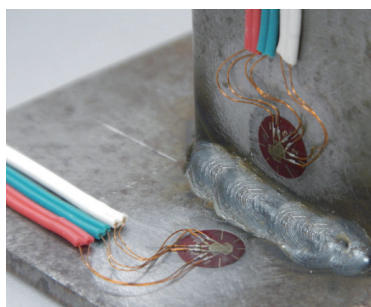
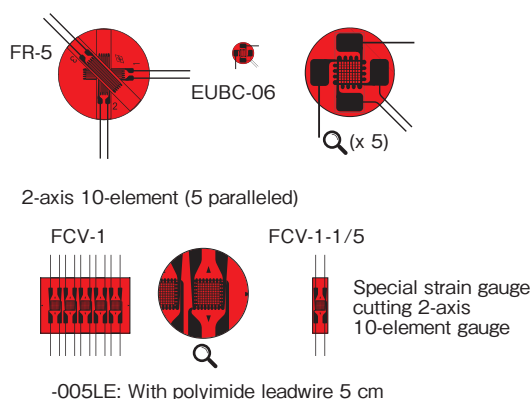
A strain gauge is installed on the measurement position, and initial unbalance value is measured. If the strain gauge and its wiring are exposed to cutting fluid, protective coatings are applied, or the leadwire is once detached and only the strain gauge part is coated before the cutting process. Cut the specimen so as not to induce machining stress. If temperature change is caused by the cutting, carry out measurement after the temperature returns to normal.

Use the same channel of the same instrument for measurements before and after the cutting. This is because initial unbalance values are not consistent for different channels or instruments.

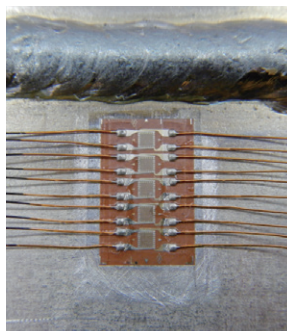
Applicable strain gauge	FR-5 (gauge length : 5mm 3-axis) EUBC-06 (gauge length : 0.6mm 2-axis) FCV-1 (gauge length : 1mm 2-axis × 5 paralleled)
Operating temperature range	-196 ~+150°C
Temperature compensation range	+10 ~+100°C
Applicable adhesives	CN

Please refer to page 43, 44, 91 and 92 for the detailed specifications.

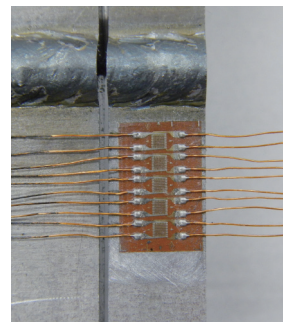
For residual stress measurement



Weld bead (rosette strain gauge)



Weld bead (strain gauge for stress concentration)



After cutting and releasing



Strain Gauge Adhesives



	Type	Contents	Component	Applicable specimen	Operating temperature	Curing temperature and time	Shelf life	
CN	Single component Room-temperature-curing	Single 2g x 5	Cyanoacrylate	Metal, Plastics Composite	-196~+120°C	Room temperature 20sec.~1 min. (thumb pressure)	6 months	
CN-E	Single component Room-temperature-curing	Single 2g x 5	Cyanoacrylate	Concrete Mortar, Wood	-30~+120°C	Room temperature 40sec.~2 min. (thumb pressure)	6 months	
CN-R	Single component Room-temperature-curing	Single 2g x 5	Cyanoacrylate	Metal, Plastics Composite	-30~+120°C	Room temperature 10~30sec. (thumb pressure)	3 months	
CN-Y	Single component Room-temperature-curing	Single 2g x 5	Cyanoacrylate	Metal, Plastics Composite	-30~+80°C	Room temperature 60 sec.~2 min. (thumb pressure)	6 months	
P-2	Two-component Room-temperature-curing Mixing ratio: 2~6%	A: 25g * B: 3g *	Polyester	Metal	-30~+180°C	Room temperature Pressure 50~300kPa 2~3 hrs.	6 months	
RP-2	Two-component Room-temperature-curing Mixing ratio: 2~4%	A: 25g * B: 3g *	Polyester	Concrete Mortar	-30~+180°C	Room temperature Pressure 50~300kPa 2~3 hrs.	3 months	
PS	Two-component Room-temperature-curing Mixing ratio: 2~4%	A: 25g * B: 3g *	Polyester	Concrete Mortar Wood	-30~+100°C	Room temperature 2~3 hrs.	3 months	
NP-50B	Two-component Room-temperature-curing Mixing ratio: 3~4%	A: 25g * B: 3g *	Polyester	Metal Composite	-30~+300°C	Room temperature Pressure 50~300kPa 16 hrs.	6 months	
C-1	Single component Heat-curing	Single 25g *	Phenol	Metal	-269~+200°C	Pre-curing at 130°C 1 hr., pressure 200~300kPa. Post-curing at 200°C 1 hr. without pressure	3 months	
EA-2A	Two-component Room-temperature-curing Mixing ratio: 2:1	A: 25g * B: 12.5g*	Epoxy	Metal, Concrete Composite	-269~+50°C	Pressure at 50~300kPa. Room temperature 1 day, or at 50°C 2 hrs.	3 months	
EB-2	Two-component Room-temperature-curing Mixing ratio: 10: 3	A: 10g x3 B: 3g x3	Epoxy	Metal Composite	-60~+200°C	Room temperature 1 day Pressure 50~200kPa.	3 months	
A-2	Two-component Heat-curing Mixing ratio: 10: 1	A: 25g * B: 5g *	Epoxy	Bolt	-30~+100°C	Room temperature 12 hrs. and 140°C 3 hrs.	3 months	

NB: Shelf life

Effective storing duration on condition that the adhesive is properly kept in a cool, dry and dark place such as a refrigerator (+5~+10°C, do not store in a freezer).

Thumb pressure 100~300kPa

SDS : Safety Data Sheet

TML supplies SDS for all its strain gauge adhesives and coatings. Contact your TML supplier for more information.

For two-component adhesives, use the supplied mixing vessels.

Mixing vessels: Polyethylene make
75mm-diameter, 10mm depth

* These contents are for outside Japan
(Dangerous Goods in Excepted Quantities)



	Applications
	Single component adhesive for strain gauges. The time required to bond the gauge is extremely short and handling is very easy. The thin bonding layer allows adhesion to plastic objects as well as metal. Measurement of large strain (post-yield measurement) is possible until the next day of bonding of the strain gauge. Note) Use protective eyewear when using this adhesive.
	Single component adhesive featuring high viscosity for bonding strain gauges to porous materials such as concrete and mortar. Note) Use protective eyewear when using this adhesive.
	Single component adhesive for accelerating cures in lower ambient temperature, or lower relative humidity. Note) This adhesive is sold only for a limited time. (from October to the next April) Note) Use protective eyewear when using this adhesive.
	Single component adhesive designed exclusively for use on post-yield strain gauge. Offers minimum degradation in bonding performance (peel strength) due to aging. Suitable when a large strain measurement is made after a few days or more of bonding the strain gauge. Measurement of large strain (post-yield measurement) is possible even after one year of bonding. Note) Use protective eyewear when using this adhesive.
	Two-component room-temperature-curing polyester adhesive for bonding PF, P and F series strain gauges. Put the necessary quantity of drug A in the supplied mixing vessel, then add drug B by drops to total 1~3% in weight of drug A. Use the mixed adhesive within 10~20 minutes.
	Two-component room-temperature-curing polyester adhesive for bonding PF and P series strain gauges. The mixing procedure is the same as above for P-2 adhesive. Put the necessary quantity of drug A in the supplied mixing vessel, then add drug B by drops to total 2~4% by weight of drug A. Use the mixed adhesive within 10~20 minutes.
	Two-component room-temperature-curing polyester adhesive. Use as a surface precoating agent for bonding P and PF series gauges to concrete and also as an adhesive for WFLM series gauges. The special filler contained exhibits alkali resistance and effectively shuts off moisture and gas from inside of the concrete. Its high viscosity enables use on vertical walls or ceilings.
	Two-component room-temperature-curing polyester adhesive for bonding QF, ZF and BF series strain gauges. Put the necessary quantity of drug A into the supplied mixing vessel then add drug B by drops to total 2~3% by weight of drug A. Use the mixed adhesive within 5~20 minutes.
	Single-component heat-curing type adhesive. For use on strain gauges that are suited to heat curing. Enables reliable measurement for long periods and in high temperature up to 200°C.
	Two-component room-temperature-curing epoxy adhesive for bonding CF series strain gauges for use in temperature from cryogenic (–269°C) up to 50°C.
	Two-component room-temperature-curing epoxy adhesive for bonding strain gauges for use in temperature from –60 to +200°C. Enables stable measurement for a long period of time.
	Two-component heat-curing epoxy adhesive for bonding BTM strain gauges.



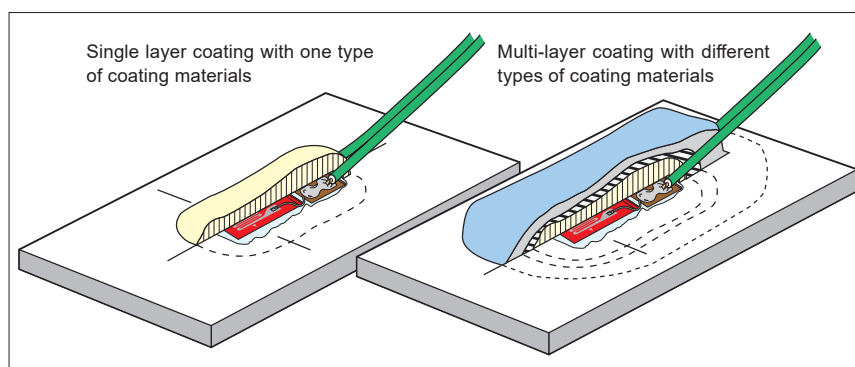
Important point

- In general, curing time of an adhesive called "room temperature curing type" is largely affected by environmental conditions such as temperature and humidity. Referring to the curing conditions described in the supplied operation manual, it is recommended to carry out a "test curing" on the site.
- A trace of water in the air is required to cure the CN adhesive (cyanoacrylate). Therefore the curing time is largely affected by humidity rather than temperature.



Coating Materials

The type of coating required and the application method differ depending on the environment in which the strain gauge is used. In general, if one type of coating is not sufficient, multiple coatings can be combined to protect the strain gauges. At TML, the coating applied directly to the surface of the strain gauge is referred to as the first coating with subsequent coating layers referred to sequentially as the second coating, third coating, etc. Multi-layer coatings offer better strain gauge protection.



Type	Materials	Color	Contents	Operating temperature	Curing conditions	
W-1	Microcrystalline wax solid	Light yellow	500g	0~+50°C	Hot melting +100~+120°C Hardening in room temperature	
N-1	Chloroprene rubber based solvent thinned	Light yellow	25g *	-30~+80°C	Air-drying A half day in room temperature	
K-1	Special rubber based solvent thinned	White	25g *	-269~+60°C	Air-drying A half day in room temperature	
UE-1	Special rubber based solvent thinned	Brown	25g *	-40~+150°C	Air-drying A half day in room temperature	
SB tape	Butyl rubber	White	10mm(wide)x3mm (thick) 5m long/roll	-30~+80°C	Pressure sensitive	
VM tape	Butyl rubber	Black	38mm(wide) x1mm (thick) 6m long/roll	-20~+80°C	Pressure sensitive	
KE-348W	Silicone rubber	White	100g	-50~+200°C	Air-drying A half day in room temperature	
KE-348T		Transparent	100g			
TSE3976-B	Silicone rubber	Black	100g	-50~+250°C	Air-drying One day in room temperature	

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Coatings in special substances

For use in special substances such as acids, alkalis and alcohols, contact TML or your local representatives.

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