Technical Literature F-07

Radiation Resistance of AURUM®

When a plastic is used in an electrical insulating material for a nuclear reactor, the radiation resistance of the plastic becomes a critical required property.

Generally, when radiation is applied to a plastic, the crosslinking of the molecules and the breaking of the main molecular chains take place at the same time. According to the proportion between them, plastics can be divided into two types: the crosslinking type and the breaking type.

For example, those plastics which have a molecular structure showing a high crosslinking rate (such as polyethylene) is called crosslinking-type polymers because their heat resistance, weathering resistance and stress cracking resistance are improved significantly by irradiation. Radiation is used as an effective means for improving the properties of plastics in some cases.

Generally, however, when a plastic is irradiated, the breaking of the main molecular chains takes place first due to the formation of double bonds, cis-trans transition, oxidation reaction, etc., causing a degradation of its properties.

AURUM® displays a behavior similar to that of a crosslinking-type polymer and has higher radiation resistance than that of the conventional thermosetting/thermoplastic polyimide resins or a representative high-performance resin PEEK.

Table 1 shows changes in the mechanical properties of plastics that took place when beta rays (electron beams) were irradiated, and Table 2 shows changes in the mechanical properties of plastics that took place when gamma rays (60Co) were irradiated. The changes are expressed in terms of retention percentage against the values as determined before irradiation.

(Japan Atomic Energy Research Institute)

Table 1 Changes in Mechanical Properties of Plastics that Took Place When Beta Rays (Electron Beams) Were Irradiated: Retention Percentage (%)

	Irradiation (Mrads)	Tensile strength	Elongation at break
AURUM®	0	100	100
	1,000	—	—
	3,000	100	90
	6,000	105	80
	9,000	110	80
	12,000	105	70
KAPTON	0	100	100
	1,000	90	60
	3,000	80	30
	6,000	80	30
	9,000	80	20
	12,000	70	15
UPILEX	0	100	100
	1,000	90	80
	3,000	—	—
	6,000	70	20
	9,000	70	15
	12,000	60	10
ULTEM	0	100	100
	1,000	40	10

Table 2 Changes in Mechanical Properties of Plastics that Took Place When Gamma Rays (60Co) Were Irradiated: Retention Percentage (%)

	Irradiation (Mrads)	Tensile strength	Elongation at break
AURUM®	0	100	100
	1,000	—	—
	2,000	—	—
	10,000	100	30
KAPTON	0	100	100
	1,000	80	20
	2,000	20	3
	10,000	—	—
UPILEX	0	100	100
	1,000	80	80
	2,000	60	40
	10,000	—	—
ULTEM	0	100	100
	100	40	10
	300	40	5
PEEK	0	100	100
	200	80	40
	800	80	10

Radiation Resistance of AURUM® (2)

Thermoplastic resins having a high heat resistance are required for use as the matrix resins of the carbon fiber reinforced plastics (CFRP) to be used in the aerospace field.

AURUM® is believed to be suitable for such uses because it exhibits a high glass transition temperature and a tendency for its high-temperature properties to be improved, rather than deteriorated, by irradiation of electron beams.

To illustrate the effects of irradiation of electron beams on the high-temperature properties of AURUM®, Fig. 1 shows changes in tensile strength, Fig. 2 changes in glass transition temperature, and Fig. 3 changes in stiffness.

(Japan Atomic Energy Research Institute)