



## Processing of KUBE Infrared Transmissive Injection Granulates

### Information for the injection molder

#### PIR granulate features

KUBE PIR Granulates are pre-mixed and highly homogenized compounds and master batches containing nano-particle IR transparent pigments and highly effective UV and ageing protectors. They are designed for the injection molding of windows, lenses, fresnel lenses or complete covers for PIR (Passive Infrared) detectors.

#### **The Type 20'000 / 30'000 / 40'000 Series feature excellent characteristics:**

- The IR transmission in the 7 to 14 microns band is substantially higher than with other plastics.
- Ideal to mold thin windows and fresnel lenses.
- Contain IR transparent pigments in a wide range of colors.
- Optimum filtering of visible light.
- UV, weather and ozone resistant for many years.
- Proven long term stability (20 years experience).
- Used in over 500 million PIR applications from consumer products to professional and military security systems.

#### Lens/Window Design

Although KUBE granulates exhibit exceptionally high transmission, PIR-windows should be as thin as possible. Recommended thickness is from 0.2 mm to 1.0 mm. As an overall compromise including mechanical stability, best results are generally obtained with 0.5 mm thickness.

#### Colors

Our white granulates, when molded 0.25 mm thick, have a similar opaqueness and appearance as our IR plastic film type 2018. Thicker windows may use a 1:1 mixture of white and natural 22300 or 22302 granulate to enhance transmission. Our materials are suitable to mold complete covers, up to 2 mm thickness where no IR transmission is required.

Color correction is possible by adding our special color dies. Generally, a 1% addition is adequate.

#### Specification

Density: 0.951 to 0.960  
Melt Index: 17g/10min. (190°-2.16 kg ISO 1133)  
Versions with 27 g/10min. are available for very thin moldings  
Melting temperature: 130°C



## Process Advice for Kube HDPE Injection Molding Materials

Entering zone 1	50 – 70 °C	(avoid to plug material in the feeding zone)
Entering zone 2	170 – 220 °C	
	(220°C if no risk of bridge by thermal conduction of the feeding zone)	
Compression zone	200 – 220 °C	
Exit zone	210 – 220 °C	
Nozzle temperature	220 – 230 °C	(230°C is the maximum temperature)

## Mold flow data

apparent dynamic viscosity  $\eta_{app}$  (apparent means: not Rabinovich corrected)  
 Measured with Length / Diameter = 15/1 at 190 degC  
 Numbers valid for Kube MFI 17 materials with small pigment contents

Shear rate	1 /s	10 /s	100 /s	1000 /s
Viscosity	490 Pa s	420 Pa s	300 Pa s	150 Pa s

Melt Volume Rate of type 22302 MVR 190 / 2.16 (ISO 1133) 22.4 cm<sup>3</sup> / 10min  
 Melt Volume Rate of type 22400a MVR 190 / 2.16 (ISO 1133) 20.2 cm<sup>3</sup> / 10min

## Tooling Recommendations

A design including a PIR window or lens should be optimized for the best possible material flow in the thin window area. Thin parts may require combined injection and compression.

Dimensional shrinkage is in the order of 1.5 to 2 %  
 (typical 1.8% , longitudinal a bit less, transversal a bit more)

The window area of a mold should be polished inside. The outside should also be polished, or the tool can be slightly chemically etched for mat, dull appearance (like the KUBE plastic films).

Some small scratches in the tool will not affect transmission and detector performance. However, coarse surface structure will result in diffraction and loss in sensitivity.

## Granulate Pre-Drying

Recommended duration 2 hours  
 standard air-drying: max. 70 degC (no clumping), convection drying: typical 60 degC



## Injection Machine Settings

Starting point for molding our granulates is a melt temperature  $T = 230^{\circ}\text{C}$  and an injection pressure of minimum 350 bar. This is good for small, simple and rather thick parts.

For lenses with 0.5 mm thickness, a maximum flow length of 70 to 100 mm is achieved with 1200 bar pressure. For flat lenses with 0.5 mm thickness, 800 to 1600 bar pressure are recommended.

Common melt temperatures are 200 to max.  $280^{\circ}\text{C}$ . At high temperatures, the melt must not stay in the cylinder (feeder worm) for too long, or it may degrade and get yellowish.

Cylinders: Typically 18...22 aspect ratio (length/diameter) with 3 zone heating. Generally, slightly ascending temperature is advantageous.

Injection should be fast to fill the tool before the melt cools down. When combustion marks (brown/black spots or areas) appear at the edge or where the melt flows together, the pressure is too high or evacuation of the air inside the tool is not adequate.

Typical tool temperatures are 20 to  $60^{\circ}\text{C}$  (up to  $70^{\circ}\text{C}$  in some cases). Due to the partial crystallization of the material, deformations may be caused by non-uniform tool temperature. Deformations may be prevented by controlling the tool temperature.

Fresnel lenses: It is generally considered that the side of the tool containing the grooves is made warmer than the other side. Sometimes, the flat side is made  $20^{\circ}\text{C}$  and the groove side  $60^{\circ}\text{C}$ .

Glossy surfaces are achieved with fast injection and high tool temperature.

## Example of typical injection machine settings

(molding of a small Fresnel lens, using black type 40700 resin)

Material temperature: 210 (nozzle) / 210 / 200 / 190 / 180 (inlet) degC

Injection pressure: 1450 bar, rate: 15 ccm/sek

post-pressure: 900 bar for 2 sek

post-pressure2: 500 bar for 0.5 sek

Feeder diameter: 22mm

Circumferential feeder velocity: 20 m/min

Feeder pressure: 250 bar (to further homogenize the material entering the nozzle)

Nozzle diameter: 2mm



## Mechanical Properties of typical Kube PIR Granulates

	Standard	Unit	Granulate type		
			22300	21821	22400a
Yield Stress	ISO527	N/mm <sup>2</sup>	23.8	23.1	22.1
Yield Point	ISO527	%	3.0	3.0	2.95
Break Stress	ISO527	N/mm <sup>2</sup>	12.0	11.6	11.1
Elongation at Break	ISO527	%	51.1	51.3	50.1
E - Module	ISO527	N/mm <sup>2</sup>	878	825	846
Notched impact strength (23°C)	ISO179	kJ/m <sup>2</sup>	3.6	3.7	3.7
Notched impact strength (-30°C)	ISO179	kJ/m <sup>2</sup>	3.3	3.8	2.9
Impact strength (23°C)	ISO179	kJ/m <sup>2</sup>	97.3	97.3	97.3
Impact strength (-30°C)	ISO179	kJ/m <sup>2</sup>	97.4	97.4	97.5

### General

Volume 1 Liter of type 22300 = 610g

Specific weight 0.95 (materials with small pigment contents), 1.17 (type 22400a)



## Series 10'000 Near Infrared Granulates

### Features:

Series 10'000 KUBE Granulates are mixed and homogenized compounds and master batches, easy to use for injection molding of windows, lenses or complete covers for near infrared (800-1000 nm) IR systems, such as remote controls, IR data links, IR wireless audio transmission, IR light barriers, photoelectric beam type alarm systems and other systems using IR LED's as transmitters.

Important: NIR material is only short wavelength IR transparent and NOT suitable for PIR.

### The type 12600 material features excellent characteristics:

- The IR transmission in the 800 to 1000 nm band is substantially higher than with other plastics and is 86% for a 1.5 mm thick section.
- Made of Polystyrene, ideal to mold thin windows and complex parts.
- For emitters (LEDs) and receivers (phototransistors, photodiodes etc.)
- Contains a visible light blocking, IR transparent pigment and improves detector operation by avoiding saturation due to daylight and artificial light.
- Good resistivity to UV, weather and ozone.
- Proven long term stability (20 years experience).
- KUBE plastics are used in many applications from consumer products to professional and military security systems.
- Intense black / dark red color.

### Lens/Window Design:

12600 is easy flow and has exceptional mechanical and thermal stability up to 60°C. Design is almost unlimited and can be done as for any other polystyrene.

Refractive index: 1.59

### Color:

When used in sections from 1 to 3 mm thickness, external appearance is black. Thinner sections are dark red.

### Molding:

12600 granulate can be processed like any other polystyrene.

Density: 1.05

Melt Index: 2.5g/10min. (200°C - 5 kg ISO 1133)

Vicat softening temperature: 101°C

### Tooling Recommendations:

Dimensional shrinkage is in the order of 0.4 to 0.6 %.

The window area of a mold should be polished inside and outside. Coarse or rough surface structure will result in diffraction and may cause unwanted loss in sensitivity. Some small scratches in the tool will generally not affect performance. However, NIR windows require higher optical quality levels as compared to PIR lenses.

Ask KUBE about other NIR materials (granulates with higher temperature stability etc.)