

General Specification, Quality Control Scheme and Aging / Degradation of KUBE Plastics for PIR Windows and Lenses

The Material:

KUBE infrared transmissive plastics are based on HDPE. Special infrared transparent pigments, stabilizers and UV protectors are added. The materials are delivered as films or as homogenized compounds (granulates) with guaranteed properties, made from raw materials of controlled purity and particle size. The user takes no risk of changing properties or compositions. Films are monitored on-line during production, and thickness profile and IR transmission are controlled over the total length.



Applications:

Covers, hoods, windows, lenses and other optics for motion detectors:

- PIR-light switches, indoor and outdoor
- PIR presence detectors
- PIR intruder alarms
- PIR door openers
- PIR traffic monitors
- Low temperature Pyrometers

Features:

- Exceptional transmission in the 7 to 14 Microns band of PIR motion detectors
- The most stable and predictable material available: 25 years of experience, used in over 400 million PIR applications from consumer products to professional and military security systems.
- KUBE plastics resist sunlight, UV, heat, dirt and ozone over many years.
- Excellent blocking of visible light reduces false alarms due to sunlight and car headlights.
- Flame retardant types available.
- Full range of colors.
- Super-White for improved visual aspect.

Processing:

Films can be cut, die-cut and vacuum-formed. Film windows are mechanically mounted in most cases. Refer also to „How to Glue KUBE Plastics“.

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. Best overall results, including mechanical stability, are generally obtained with 0.5 mm thickness.

Colors:

KUBE granulates are available in nature (opaque translucent), white, beige (ivory) and black as standard products. The 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 (indoor use) or 22302 (outdoor use) to enhance transmission. Our materials are suitable to mold complete covers, up to 2 mm thickness in areas where no IR transmission is required.

- Color correction is possible by adding our special color dies. Generally, a 1% addition is adequate.
- All KUBE granulates can be mixed without risk of loss of stability. This is especially useful to mix gray shades from white and black or ivory from white and beige. Please, consult KUBE for recommendations.
- Further colors (olive, brown, red, blue etc.) on request.

Specification:

Density:	0.951 to 0.960
Melt Index:	17g/10min. (190°-2.16 kg ISO 1133) 27g/10min. for easy flow types
Melting temperature:	130°C

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 %.

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 matt, dull appearance (like the KUBE plastic films). Coarse surface structure will result in diffraction and loss in sensitivity. Some small scratches in the tool will not affect transmission and detector performance.

Injection Machine Settings

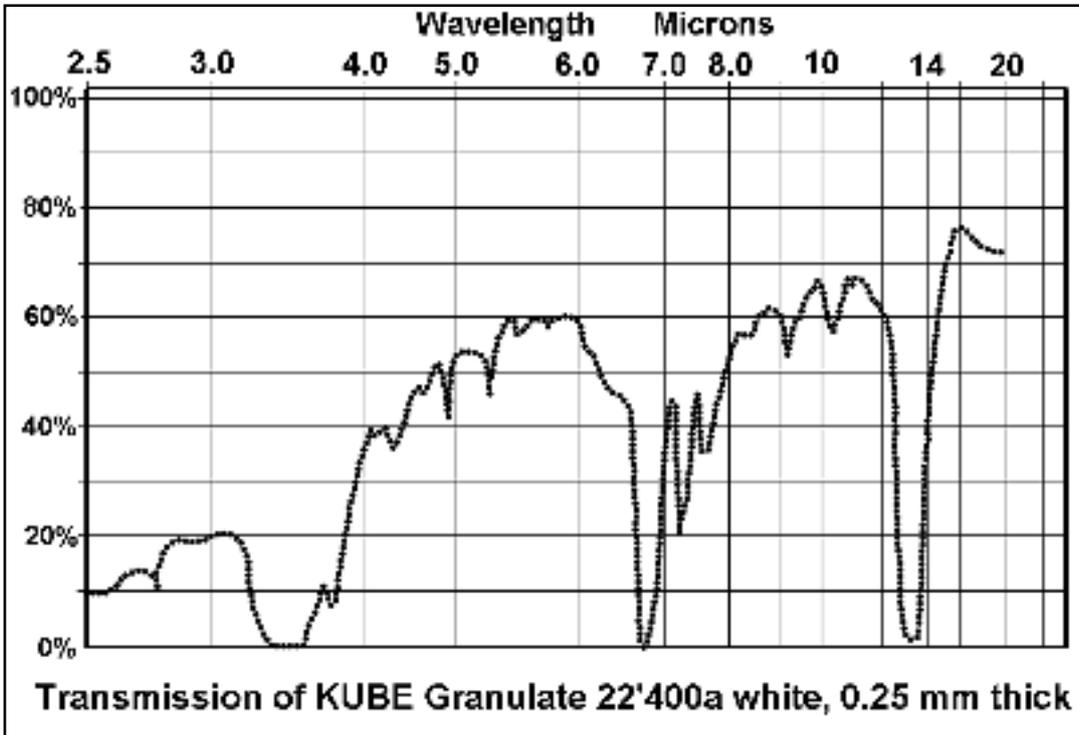
Please refer to the “Granulates Processing” document.

Optical and Mechanical Properties:

IR and light transmission, dimensions and thermal properties are listed in the document „Plastics Properties“, available in its latest update on www.kube.ch

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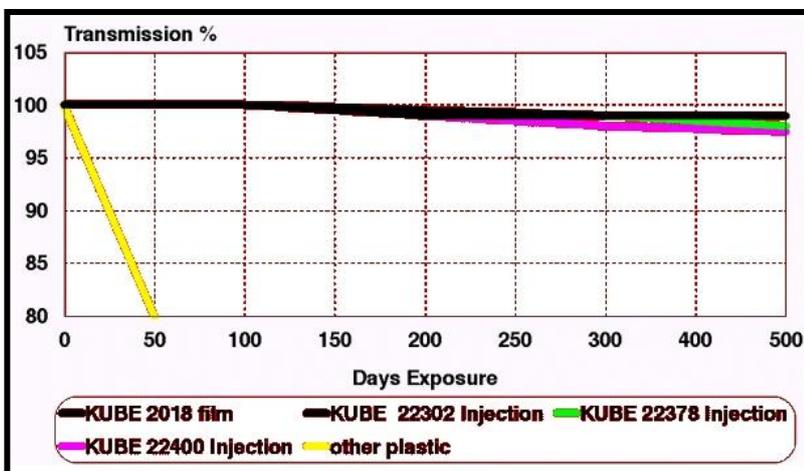
Most films and granulates are flame retardant to IEC 695-2-1 and impact proof to IEC 669-1, attested by the Swiss SEV, and an approval is available for military applications attested by the French GIAT.



Refractive index at 7...14 microns wavelength is 1.52, optical dispersion is negligible.

Long Term Stability of KUBE PIR Transmissive Plastics

The long term stability of HDPE in outdoor applications is not unproblematic, and several plastics used in the industry suffered severe degradation within short time.



KUBE PIR Plastics are:

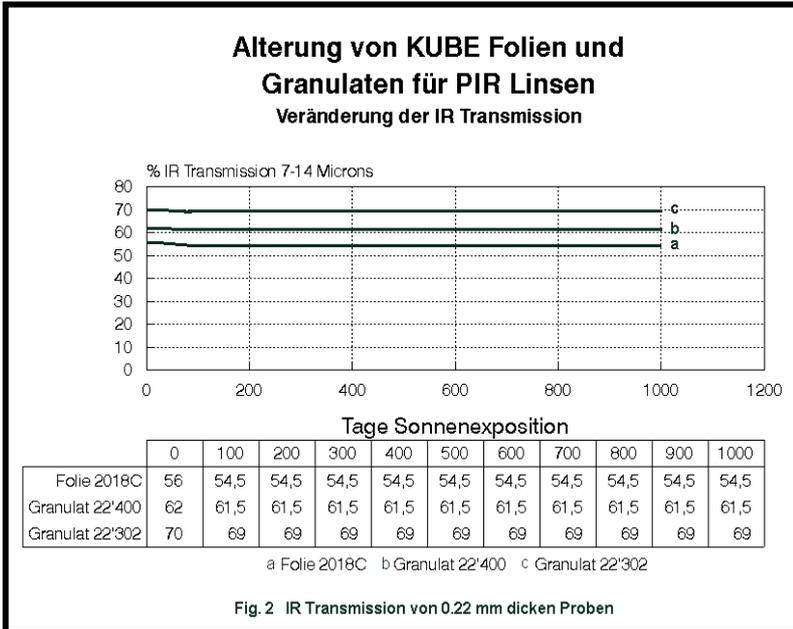
- resisting heat, sunlight, ozone and contaminants for many years.
- maintaining excellent IR transmission over time.
- maintaining their mechanical properties.

KUBE makes use of specially developed pigments of controlled purity in combination with a 3-fold ultraviolet stabilization scheme.

- Manufacturer of Passive Infrared (PIR) Components Since 1981 -

Tests performed at KUBE as well as results from customers and test facilities confirm the unsurpassed stability in real world situations and also in accelerated aging tests.

Typical results of a 3 year exposure test



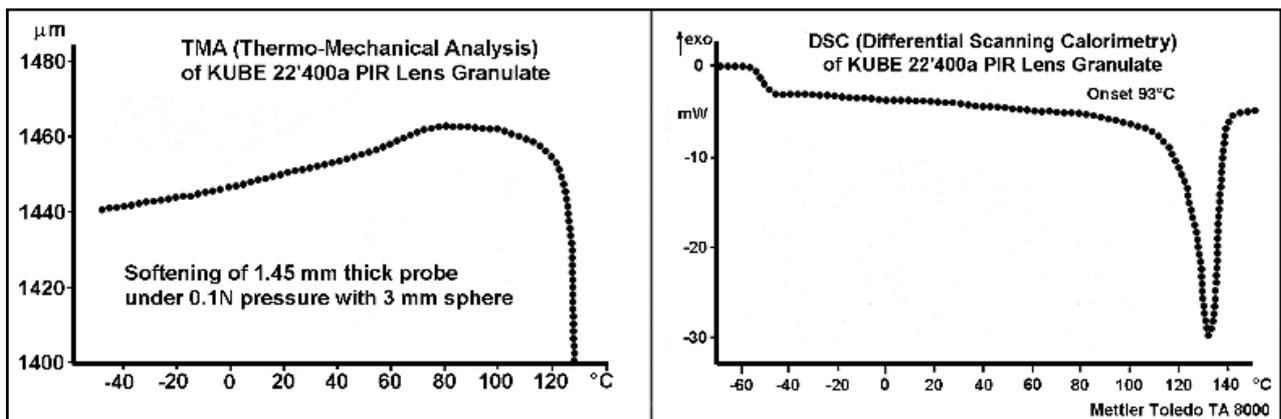
The graph shows the change of infrared transmission over 1000 days for probes of 0.22 mm thickness and various KUBE materials.

The test has been performed in our mountain test site, located at 1300m (4000') altitude, with direct south exposure (Global radiation 4000 MJ/m²a).

A small reduction of infrared transmission can be observed in the first 100 days of exposure, due to dust and dirt particles adhered to the surface. However, this effect remains constant with time.

Test results: virtually no degradation of mechanical or optical properties was observed over the 3 year test period.

Temperature Behavior



The TMA analysis shows the excellent dimensional stability of KUBE granulates over a wide temperature range. All KUBE PIR plastics can be used over a temperature range of -40 ... +85°C. According to the DSC plot, there are no phase transitions and no glass phase formation within this range.

Please note that granulates for use in Near IR applications like the type 12600 show different characteristics. Ask KUBE for more information on NIR materials.

KUBE Quality Assurance



Since 1981, KUBE follows the essential quality control schemes of GMP standards, and specifically the use of history tags. This means that the customer is assured that each lot of material has:

- **A guaranteed composition and purity.**
- **The specified infrared characteristics and light transmission values.**

This eliminates the need for an incoming inspection by the customer.

Each roll of film or bag of granulate is marked with the relevant production data and optical properties. Test protocols are supplied on request.

All process data is stored during 10 years. Complete production information and composition is deposited at the legal auditors of KUBE, and is to the disposition of our customers in any event of force majeure.

Tests performed:

- 1) Films, granulate samples, plaquettes as well as pressed samples are visually inspected for color spots and impurities. If the specification is exceeded, the lot is rejected as a whole.
- 2) One sample per lot is submitted to spectral analysis on a IR Spectrometer. The spectrogram is only used as a qualitative judgment of changes and appearance of absorption bands that are normally not observed. A production lot is not rejected upon a change in the spectrogram, but further analysis may be induced.
- 3) One measured sample per lot goes to the KUBE outdoor test site for an extended exposure in direct sun.
- 4) Optical test: Film samples or injected and pressed samples from the beginning and end of production are measured to infrared and optical properties.

Infrared transmission is measured in the 7 to 14 microns band (optical bandwidth +/- 5%) with a pyroelectric sensor, a PE lens with 22 mm focal length and a large area modulated source of 300K. Transmission is measured as relative to 100% calibration and is always done with the same instrument, as other instruments may give slightly different results (especially when high temperature sources are used).

"Actual Transmission including reflection losses per 1/10 mm" calculates as
 $AT = (\text{measured transmission} / 0.92)^{1/(\text{thickness in mm} / .1)} * 0.92$
and corresponds to a film of 0.1 mm thickness, including surface reflection.

"Bulk Absorption per 1/10 mm w/o reflection" calculates as $BA = 1 - (AT / 0.92)$
and corresponds to the absorption (extinction) of a 0.1 mm thick layer of material without surface reflection. This is the pure material property.

Straylight transmission (stray) is measured with visible light at 555 nm wavelength. All light from a green LED passing the sample is detected with a large area photocell. In parallel to BA, these results are also converted to material properties per 1/10 mm:

"stray" = $1 - (\text{measured straylight} / 0.92)^{1/(\text{thickness in mm} / 0.1)}$

Collimated light transmission (dir) is measured with a collimated beam of 555 nm wavelength. The test arrangement corresponds to a motion detector with 22 mm focal length, i.e. a photocell of 1x2 mm area 22 mm behind the film detects directly passing radiation, while the environment is black, absorbing the straylight.

"dir" = $1 - (\text{measured direct light} / .92)^{1/(\text{thickness in mm} / .1)}$

^ means power (exponent)

Although thickness is corrected in this calculation fairly good for the tolerances appearing in preparation of the samples, wide spreading values of thin (0.2 mm) and thick (1.2 mm) probes cannot be compared directly. The difference is due to forward-diffraction (multiple diffraction).

Judgment for lot acceptance is done for samples with a specific thickness (+/- 5%) and upon numbers ("expected values") fixed by experience, customer acceptance and approval, or by comparison with approved samples.

Plastic films are monitored continuously during production to composition, thickness profile over width, IR transmission and light transmission, and, for special colors, with colorimetry.

RoHS Compliance:

All Kube plastic materials conform to the most recent RoHS (Reduction of Hazardous Substances) directives and are not subject to TSCA (Toxic Substances Control Act).

Additional material data and product information can be found on
www.kube.ch/plastics/index.php