



# Protective IR Windows for Unmanned Aerial Vehicles

We offer a series of thin polymer films with high transmissivity in the second infrared atmospheric window, 8 to 13  $\mu\text{m}$  range (see fig. 1), for the purposes where traditional crystalline IR materials, such as germanium, silicon, zinc selenide or sulfide, are economically or technically infeasible. The films are quite transparent in the first atmospheric window as well, but only in a part of the window, namely in the long wave range, 4 to 6.5  $\mu\text{m}$ . Transparency of the films in the visible range is between a few percent and fifty percent, depending on film type (see fig. 2).



Technical characteristics of the films are given in the table below.

Properties	OP-190	OP-380	OP4-380
Thickness, $\mu\text{m}$	190	380	380
Refractive index in visible range	1,53	1,53	1,53
Refractive index in 8-14 $\mu\text{m}$	1,54	1,54	1,54
Refractive index above 15 $\mu\text{m}$	1,48	1,48	1,48
Tensile strength, $10^4$ PSI	14...38	60...180	60...180
Flexural strength, $10^3$ PSI	8...60	100..260	100..260
Shore hardness	D40-50	D60-70	D60-70
Thermal expansion coefficient, $10^{-5}/^\circ\text{C}$	10...20	11...13	11...13
Maximum operating temperature, $^\circ\text{C}$	65	100	100
UV stability	stable	stable	stable
Degradation under sunlight	cracking	none	minor
Degradation under weak acids	insignificant	very insignificant	insignificant
Degradation under weak alkalis	insignificant	very insignificant	insignificant
Degradation under organic solvents	insignificant	insignificant @ $T > 60^\circ\text{C}$	insignificant @ $T > 60^\circ\text{C}$

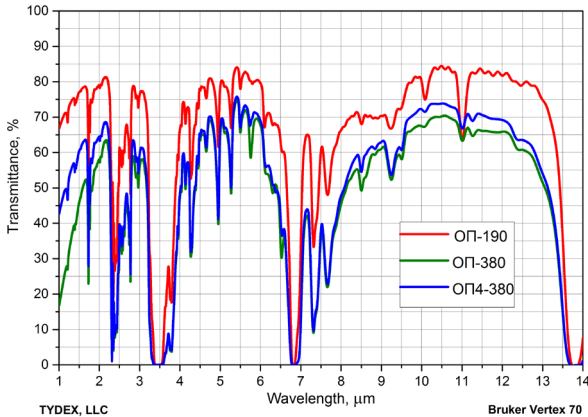


Fig. 1. Transmissivity spectrum of the IR films for UAV applications in 1-14  $\mu\text{m}$  range.

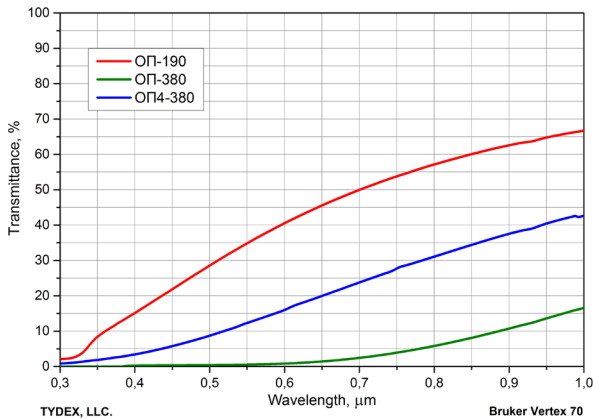


Fig. 2. Transmissivity spectrum of the IR films for UAV applications in visible range.

IR films are light and flexible, making them ideal protective optical windows used in unmanned aerial vehicles (UAV). UAVs are used for aerial and ground-based IR photography and filming of static and moving objects, including people, vehicles, forest fires, oil and gas pipelines.

The disadvantages of crystalline IR materials compared to IR films are associated with the high cost of the IR crystals themselves and the necessity of antireflective treatment to avoid high reflection losses on crystalline surfaces. The refractive indices used in the thermography of IR crystals lie in the range from 2.15 to 4.10, while for these polymers it is 1.53-1.54. Therefore, IR films do not need optical coatings, while coating increases the cost of crystalline IR windows. Lightness of polymer windows is important for lightweight aerial vehicles and is a major advantage over heavier crystals, as well as the ability to form flexible windows to any required shape.

Maximum available film dimensions are 400x250mm.

We also produce windows from IR films of the required sizes, including framed windows per customer's drawings.