

TN2015-01: Calcium Fluoride CaF_2

Calcium Fluoride (CaF_2) is a crystalline material that occurs naturally as fluorspar. When occurring naturally, CaF_2 is often strongly coloured due to the presence of colour centres. In pure form, CaF_2 is a very useful material for a wide range of optical applications due to its wide transmission range from 130nm to 10 μm for the purest material.

CaF_2 also offers low axial and radial stress birefringence and high refractive index homogeneity. All these characteristics make it the material of choice for many UV applications.

It is also a very good material for applications in the visible and IR and especially where the application involves a spectrally broad wavelength range, its low refractive index (approx. 1.43-1.44 in the visible) and resulting surface reflectivity often removes the need for an anti-reflection coating.

Apart from being used as a material for optical substrates, CaF_2 is also commonly used as an optical coating material.

When compared to BK7 or Fused Silica, CaF_2 is much softer with a Mohs hardness of 21 (SiO_2 : 100, Al_2O_3 : 400). This makes it a more difficult material to polish to a high surface quality as the material and while '10-5' is a standard scratch-dig specification for materials like BK7 or Fused Silica, CaF_2 is generally only specified as '20-10' or even worse.

To achieve high optical coating quality combined with a high Laser-induced damage threshold (LIDT), it is important to have a very good scratch-dig specification as well as a very good RMS roughness.

Manx Precision Optics Ltd. (MPO) is a company well known for its manufacture of high LIDT components. To achieve the best results, MPO undertakes the full manufacturing process of optical components - shaping/grinding/ polishing/coating/assembly in-house, giving the company full control over the entire process.

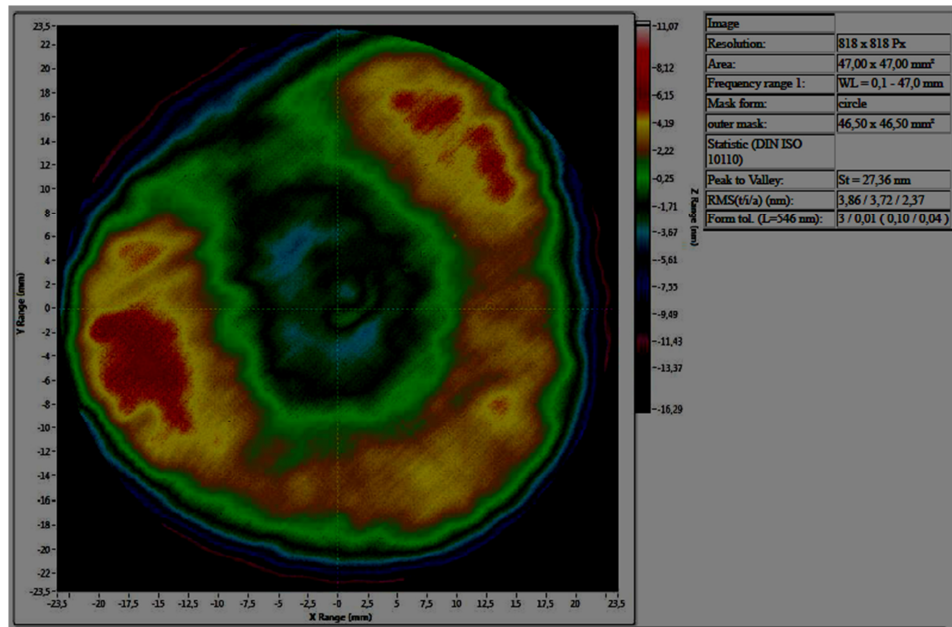
With its highly experienced workforce the company therefore developed a polishing process to achieve the highest surface quality on CaF_2 substrates. This opens up new applications for CaF_2 in combination with high LIDT applications.

This is best demonstrated by a typical example - a 50.8mm diameter substrate.

The flatness over >90% clear aperture is $\lambda/20$ as the interferogram illustrates. Two measurements undertaken with a profilometer (50x magnification, checked area approx. 170 μm 170 μm) between the centre and the edge of the

clear aperture demonstrate the excellent RMS roughness of $<0.2\text{nm}$ (2 Angstrom) that MPO can achieve.

Flatness and surface quality standards of this type make the substrate usable for very high end applications, especially where low scatter losses and a high LIDT are essential.

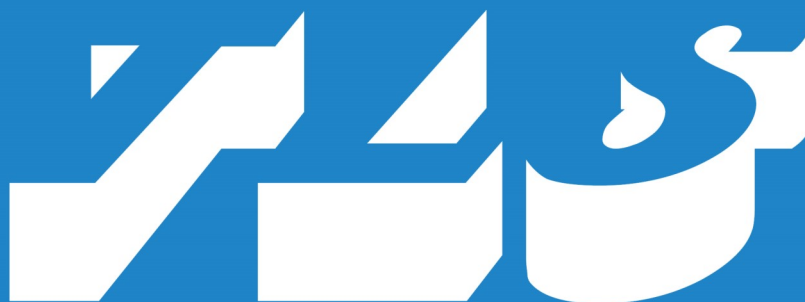


Interferogram demonstrating the excellent surface flatness achievable in a 2" (50.8mm) diameter CaF2 substrate

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