TN2017-01: Ultrafast Mirrors

In comparison to standard laser line or broadband mirrors, mirrors for ultrafast applications stand out by generally being required to show a good and even reflectivity as well as group delay dispersion (GDD) over the same range. Generally speaking, a high laser-induced damage thresholds (LIDT) is also needed.

From an optical design point of view, these requirements raise specific challenges. A standard laser line, high-reflecting mirror design is usually a stack of alternating coating layers of high and low refracting index, each with an optical thickness of $\lambda/4$. Apart from a high LIDT, the advantage of such a design is also the relatively good GDD performance.

In such a design, the breadth of the reflectivity band is determined by the ratio of the refractive indices of the low- and high refracting materials. This is illustrated in Fig 1 below.

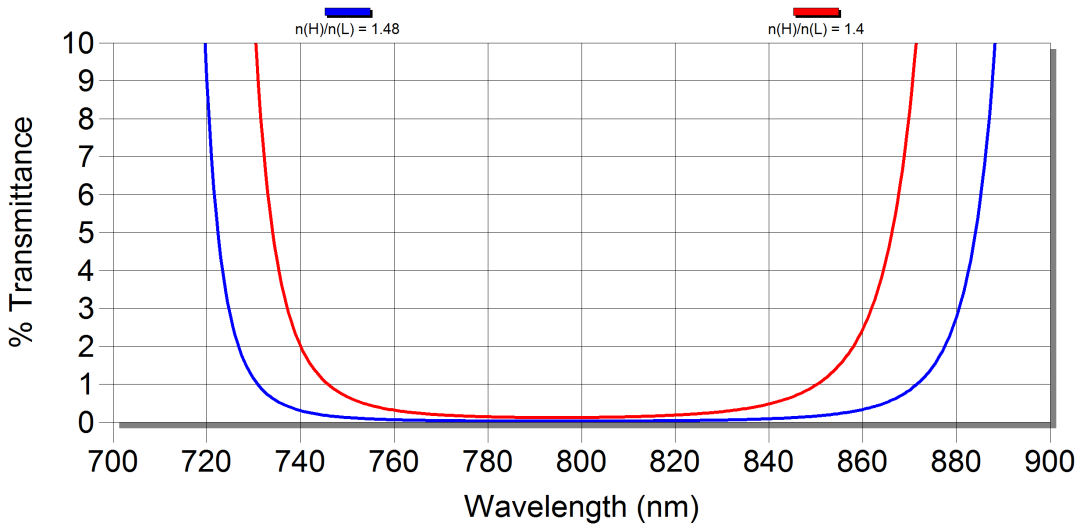

Fig. 1: Breadth of reflectivity band, shown at 45°p-POL for a ratio of 1.48 (blue curve) and 1.4 (red curve)

When dealing with ultrafast pulses it also becomes apparent that the LIDT of a coating material decreases as the refractive index increases (see MPO Technical Note TN2016-01).

Combing three coating materials over 2 partial stack is a solution that allows the mirror to maintain an acceptable LIDT combined with good GDD performance and a broader reflectivity band than a standard, high LIDT design based on two coating materials. However, the disadvantage of such a design is that the higher stress in the coating can lead to coating damage under vacuum (crazing due to stress in the coating), especially when used on larger mirrors. Furthermore, the LIDT depends very much on the power distribution in the laser pulse.

MPO has undertaken in-depth research and development to find a solution that offers excellent vacuum compatibility and a broad reflectivity band while maintaining a superior GDD performance and LIDT.

Essential for this research and development is MPO's white light interferometer which allows the measurement of the GDD of all ultrafast optics manufactured and provide customers with measured, rather than just theoretically calculated curves.

The spectral performance of MPO's broadband mirror is illustrated in Fig 2. The coating design is fully scalable and can be applied to optics from a few mm to 300mm diameter.

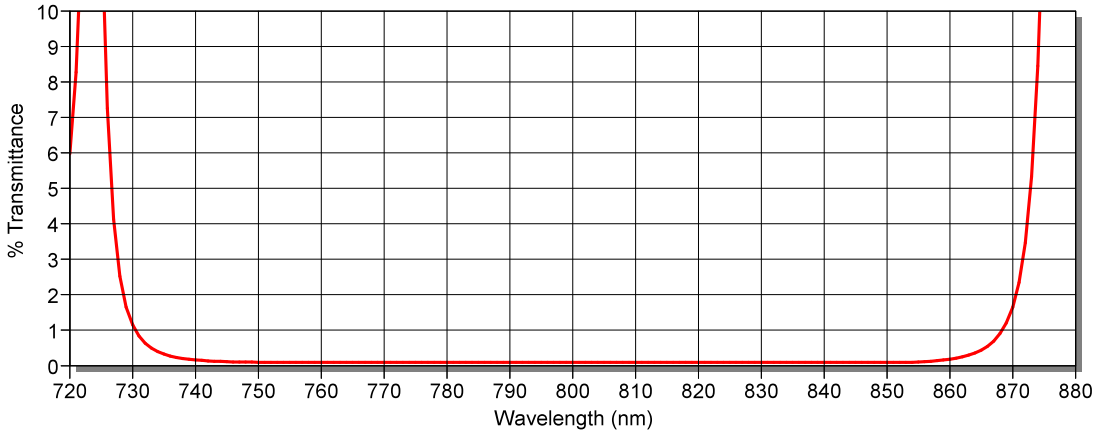

Fig. 2: MPO's broad band ultrafast mirror, performance shown for 45deg p-POL

The coating design can also be modified to give a small amount of leakage for beam analysis purposes. When looking to specify a leaking mirror, MPO recommends to work with s-polarised light as this will allow for the specification of a much tighter leakage tolerance.

MPO also offers a wide range of partial reflectors and polarisers for ultrafast applications (both plate and cube) with a large number of components being available from stock. MPO manufactures both substrates and coatings in-house, giving the company a very high degree of flexibility and allowing for very competitive prices.

For further information, please do not hesitate to contact us.
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