

# Micro-machining of transparent materials

With femtosecond laser pulses it is possible to machine materials even if they are transparent at the laser wavelength being used. The highly non-linear nature of the interaction between sample and pulse is the key to precise and clean machining of a wide array of materials with one and the same tool.

## The BlueCut - a fiber-based micro-Joule femtosecond laser



### KEY FEATURES

- Wavelength 1030 nm
- Pulse energy: >10  $\mu$ J
- Pulse duration: <400 fs
- Up to 10 MHz repetition rate
- Integrated AOM for external gating and energy tuning

The BlueCut is an ideally suited solution for ultrafast laser inscription. It's a stable, robust and compact laser. It is easily integrated into the laser writing setup and provides energy tuning, synchronization to scanner or stage movement via a TTL interface, and a simple and intuitive graphical user interface out of the box. Extremely productive processes are possible due to the high repetition rate. This is combined with high reliability and low cost-of-ownership.

## Manufacturing optical elements

### - utilizing new spectral ranges of light more efficiently

Using ultrafast laser inscription, a technique which locally modifies the index of refraction of a transparent material, volume gratings were fabricated in Gallium Lanthanum Sulphide (GLS) glass. With the BlueCut this technique uniquely enables the fabrication of volume phase gratings directly in a material which transmits all the way from 500 nm to 10  $\mu$ m. The gratings are designed for highly efficient diffraction from the near- to mid-infrared wavelength range.

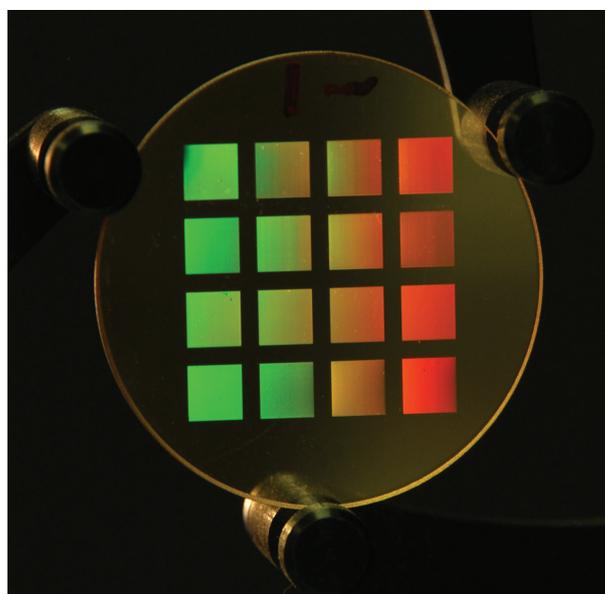


Image courtesy: Prof. Robert R Thomson, Heriot Watt University

## The photonic dicer - improving the performance of astronomical instruments

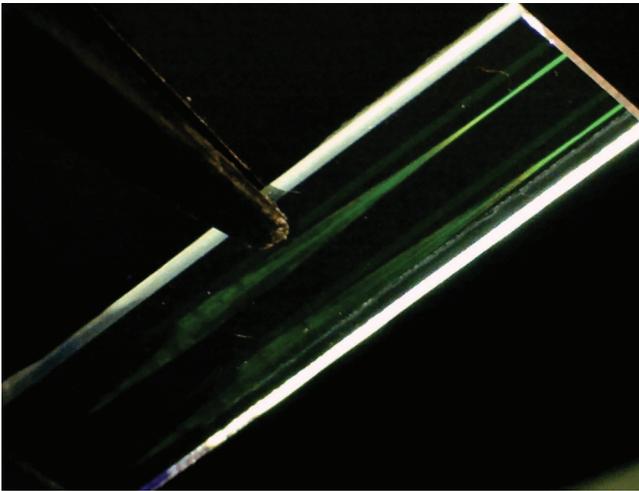


Image courtesy: Prof. Robert R Thomson, Heriot Watt University

This optical element consists of a pair of waveguides which were inscribed using the BlueCut laser. Designed for near-infrared astronomical applications, it offers a fully integrated alternative to contemporary fiber-based approaches and enables the multimode stellar light collected by a telescope to be reformatted efficiently. This can help minimize the length of the pseudo-slit as well as reduce detector noise in future astronomical instruments.

## Integrated optical elements - novel processing techniques open up new applications

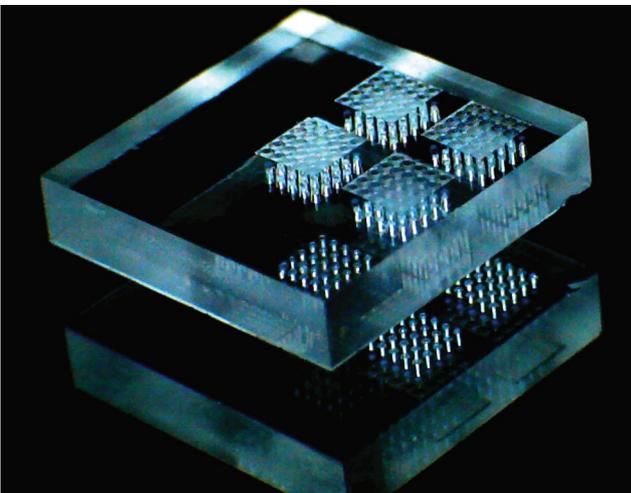


Image courtesy: Prof. Robert R Thomson, Heriot Watt University

Using the focus spot from the BlueCut femtosecond laser source as an essentially unrestricted “tool-path”, it is possible to directly write the surface of a lenslet in three dimensions within the volume of a transparent material. The lenses can then be etched and a high surface quality can be achieved by using an oxy-natural gas flame to polish the roughness caused by etching. The shape and position of each lenslet can be tailored to match the spatial positioning of a two-dimensional array of multimode fibers, which can be monolithically integrated with the micro-lens array.

