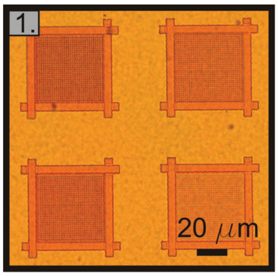
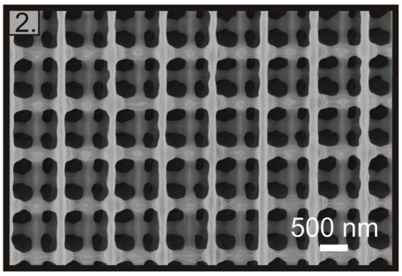
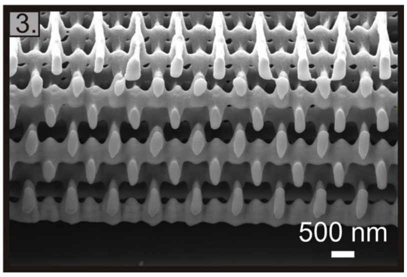
Data Sheet:
As_2S_3 - High Refractive Index Photoresist

Nanoscribe GmbH is pleased to offer to you a high-refractive index photoresist system for 3D micro- and nanolithography. This negative-tone photoresist system has a refractive index *n* equal to 2.45, and is based on the material arsenic trisulfide (As_2S_3). Together with the Nanoscribe 3D laser lithography system, it enables the fabrication of microstructures such as waveguides, couplers, splitters and resonators, and 3D structures such as photonic crystals, all of which would benefit from a material with an inherently high refractive-index.

Technology:
As_2S_3 is a direct band-gap, amorphous semiconductor that has an $n = 2.45$. Using a highly controlled deposition process that we have developed in-house, a photo-polymerizable film of As_2S_3 can be deposited on standard silica glass substrates. This photo-polymerizable film has an $n = 2.32$ and is sensitive to 2-photon polymerization. Photo-pattering of this film results in the cross-linking of the material and a concomitant increase of the *n* to 2.45. Due to this refractive index contrast, structures such as 3D woodpile structures can be immediately observed directly after writing. Figure 1 shows such a set of structures. The darker regions are the polymerized areas.







To free the 3D structure from the surrounding material, we provide a wet-etchant which removes the un-polymerized material with high selectivity. This proprietary liquid etchant is designed to take the guess-work out of an otherwise complicated chemical system, so the end user can focus on the fabrication and implementation of their designs.

The entire photoresist system enables high-quality 3D structures with an $n = 2.45$ to be fabricated. As examples, As_2S_3 woodpile photonic crystals produced using this high-refractive index photoresist system are shown in Figures 2 and 3.

Simple 2-step processing:
Step 1: Substrates are delivered with a pre-coated thickness of photoresist that satisfies the customer's particular application needs. The photoresist is fully compatible with the Nanoscribe 3D laser lithography system, and can be directly mounted for immediate use. There are no pre-processing steps necessary.

Step 2: Once the photo-structuring is complete, the photoresist is simply placed into the highly selective wet-etchant, where it remains until the structure is fully developed. No complicated post-processing steps are necessary.

Scope of supply:
The complete “As_2S_3 high refractive index photoresist system” consists of:

- Silica glass substrates pre-coated with the desired thickness of photoresist
- A corresponding amount of photoresist developer system (HS1 etching system)

Material performance:

- Index of refraction after photo-polymerization is 2.45 at the wavelength of 1550 nm
- Lateral line widths down to 200 nm are routinely achievable[1]
- Transmittance is > 95% in the wavelengths between 550 nm to 3 µm
- 3D etch selectivity is > 300:1
  (rate of removal of unexposed area : rate of removal of photo-polymerized areas)

Laboratory requirements:

- Standard chemical fumehood
- Standard laboratory safety equipment (safety glasses, gloves and lab coats)
- Magnetic stir-bars and stirring plates
- Common chemical solvents for cleaning (acetone)
- Appropriate chemical waste disposal

We can also provide custom coatings of the As_2S_3 photoresist on various substrates (e.g. quartz, silicon, GaAs, etc) for special applications. Please contact our technical and sales staff for further inquiries and price quotations.

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[1] These linewidths are guaranteed in combination with the Nanoscribe 3D laser lithography technique. Please note that the lines in this case are typically elongated by a factor of 8 along the direction perpendicular to the substrate surface. By insertion of proprietary optical systems this factor can be reduced to about 5.