Lehigh University
Center for Optical Technologies

Novel High Resolution Chalcogenide Glass Photoresists*

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What are chalcogenide glasses? Materials containing S, Se or Te.

Useful properties:
- easy to deposit large array in high vacuum
-photosensitive to band gap light (2-2.5 eV), e-beam, X-rays
- resistant to acids often used in semiconductor industry for etching
- resistance to alkaline solvents is influenced by irradiation
- can act as a positive as well as a negative photoresist, depending on the chalcogenide glass composition, pretreatment and the etchant

Sample Preparation: Deposit thin films of As-S glasses onto a glass substrate by vacuum evaporation of bulk glass

Sample Exposure:
•halogen lamp (14 mW/cm^2) through Cr grey mask
•electron beam lithography (250 – 500 μC/cm^2)

Kinetics of Dissolution:

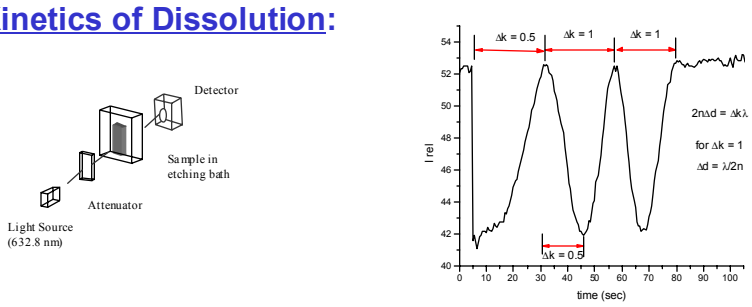

Fig. 1 Experimental set up for kinetics of dissolution studies and measured time dependences of transmitted beam intensity during etching of as-prepared $As_{35}S_{65}$ thin layers (d_0 = 330 nm) in a non-aqueous amine based solvent.

Positive etching – aqueous alkaline solvents (NaOH, Na_2CO_3, ..)

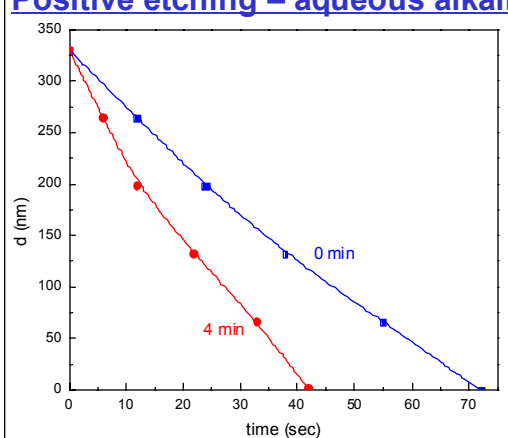

Fig 2. Kinetics of dissolution of as-evaporated and 4 min exposed As_2S_3 layer (d_0 = 330 nm) in aqueous solution of Na_2CO_3 + $Na_3PO_4.12H_2O$

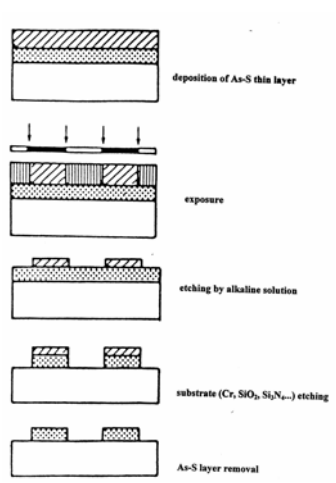

Fig. 3 Positive inorganic photoresist

Negative etching – non-aqueous amine based solvents and/or photoinduced Ag diffusion

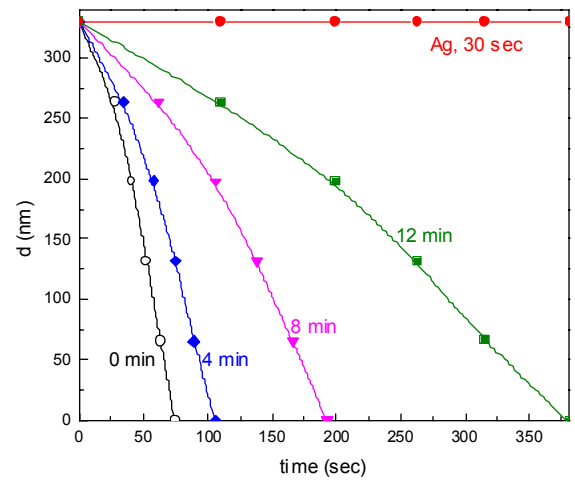

Fig. 4 Kinetics of dissolution of As-S layer (d_0 = 330 nm), as-evaporated and exposed for different times in non-aqueous amine based solution. Curve Ag, 30 sec stands for As-S sample on which 80 nm Ag was deposited and then exposed for 30 sec from As-S side.

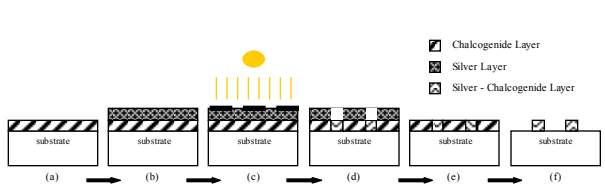

Fig. 5 Negative inorganic photoresist

Applications: micro-optic elements, nanolithography, etc.

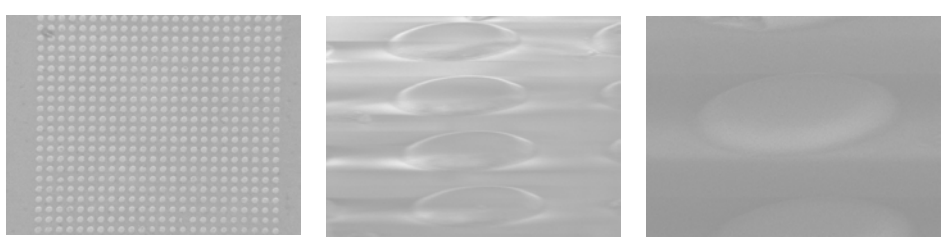

Fig. 6 Microlens arrays fabricated in As-S thin layer using exposure through gray Cr mask with subsequent etching in non-aqueous amine based solution

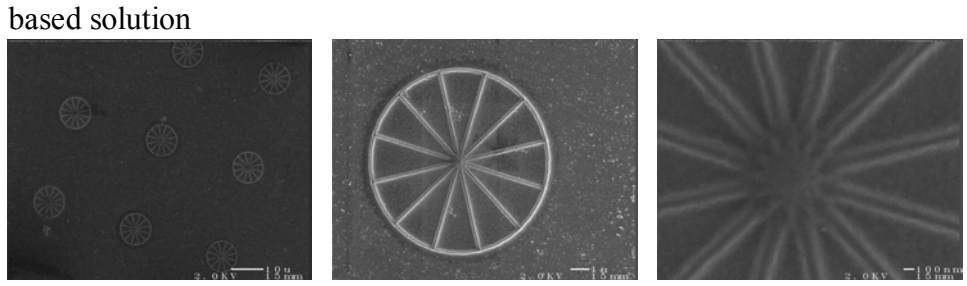

Fig. 7 "Nanowheels" fabricated into As-S thin layer by electron beam lithography and subsequent wet etching. Thickness of single line – 120 nm. Resolution - 20 nm.

Supported in part by National Science Foundation