Selective Amorphization of Thin Film Metals with ELA for Corrosion Protection in MEMS Production

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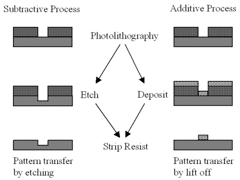
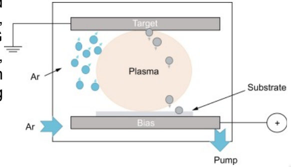
Abstract

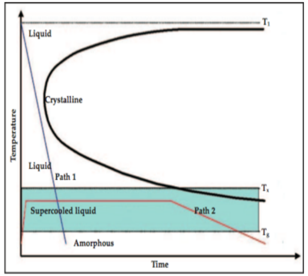
Thin Film Metallic Glass has recently been finding usages in MEM production. This project sought to utilize a new method for TFMG production using excimer laser annealing that would allow selective amorphization. Hopefully, this could have be used to take advantage of the improved corrosion properties of metallic glass to possibly remove the required masking step in MEMS production.

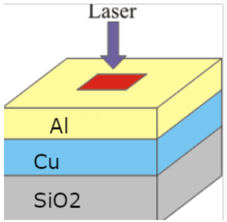
Background

- Thin film metallic glass has been finding usage in MEMs for its enhanced durability
- Currently TFMG is produced using a form of co-sputter deposition
- ELA lasers could provide an alternative synthesis which could allow greater control and selective amorphization
- We sought to take a multilayered sample and use ELA to rapidly melt, mix and cool the alloy to form a TFMG
- MG has improved corrosion resistanc, we sought to utilize the difference in etching rates to remove the masking step in MEM production









Methods

Sample Synthesis

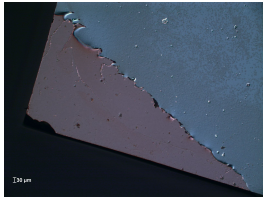
We deposited 30 nm of Cu onto 200 nm Al, as well as 600 nm of Al on 110 nm Cu samples using an Angstrom Deposition system in the clean room.

ELA Annealing

The samples were irradiated using ELA from a power range of 1.96 mJ-6.29 mJ, as well as using multiple shots to try to increase mixing.

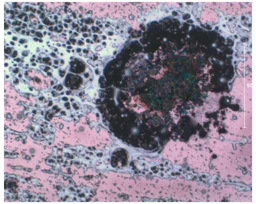
Analysis

The samples were examined using light microscopy. We planned to analyze using XRD as well as EBSD to check for grain structures. However, upon realizing our samples were over ablated we did not proceed to the next steps.

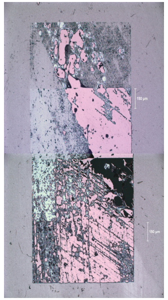


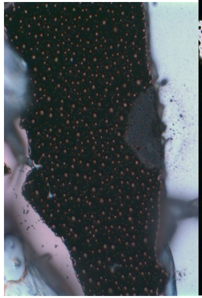
Conclusion

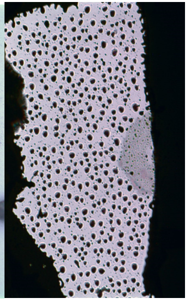
Unfortunately the project was preemptively stopped during a crucial duration for the project's success. With the current results it is hard to draw any conclusions. In our limited sample size we did not find the correct power for annealing and ablated too much material rather than achieving controlled melting. Based off other papers on the subject, laser quenching can be used to create AlCu TFMG at the eutectic composition from a codeposited sputter sample. The possible issues from trying to amorphize a multilayered sample then would be difficulties in reaching a homogenous solutions during the melt duration.



Results







Future Goals

As the project was preemptively ended it could be a future project for another senior designer. There are multiple improvements they could make to improve the process and refine the goals.

- Rather than seek to amorphize multiple layers a possible route would be to create a target for sputter deposition at the eutectic composition and try to sputter deposit thin film to work with
- Reducing the thickness of the samples by depositing new samples at much thinner thickness
- Transforming amorphous areas into single crystals is a possible topic of exploration of TFMG due to the ability to transform metastable compounds below the melting point.

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