SLATT UNDERGRADUATE RESEARCH FELLOWSHIP
FINAL REPORT

SCHOLAR NAME:	Melanie Perez
FACULTY ADVISOR:	Svetlana Neretina
PROJECT PERIOD:	02/2021-05/2021
PROJECT TITLE:	Epitaxially aligned single-crystal gold nanoplates formed in large-area arrays at high yield
CONNECTION TO ONE OR MORE ENERGY-RELATED RESEARCH AREAS (CHECK ALL THAT APPLY):	**(X) Energy Conversion and Efficiency** **( ) Sustainable and Secure Nuclear** **( ) Smart Storage and Distribution** **(X) Transformation Solar** **( ) Sustainable Bio/Fossil Fuels** **( ) Transformative Wind**

MAJOR GOALS AND ACCOMPLISHMENTS

Summarize your research goals and provide a brief statement of your accomplishments (no more than 1-2 sentences). Indicate whether you were able to accomplish your goals by estimating the percentage completed for each one. Use the next page for your written report.

RESEARCH GOALS	ACTUAL PERFORMANCE AND ACCOMPLISHMENTS	% OF GOAL COMPLETED
Hexagonal Au Arrays	Successfully have fabricated high-yield hexagonal Au arrays on sapphire.	100
Triangular Au Arrays	Have fabricated triangular arrays, but are resolving size disparity issues.	50
Large Hexagonal Growth	Have grown hexagons 10x bigger (3 micron), but would like to get to 100x.	30
Amorphous Substrate Growth	Have successfully grown hexagons and triangles on amorphous glass.	100

RESEARCH OUTPUT

Please provide any output that may have resulted from your research project. You may leave any and all categories blank or check with your faculty advisor if you are unsure how to respond.

CATEGORY	INFORMATION
EXTERNAL PROPOSALS SUBMITTED	(Sponsor, Project Title, PIs, Submission Date, Proposal Amount)
EXTERNAL AWARDS RECEIVED	(Sponsor, Project Title, PIs, Award Date, Award Amount)
JOURNAL ARTICLES IN PROCESS OR PUBLISHED	(Journal Name, Title, Authors, Submission Date, Publication Date, Volume #, Page #s) Nano Research, Epitaxially aligned single-crystal gold nanoplates formed in large-area arrays at high yield, Trevor B. Demille, Robert Neal, Arin S. Preston, Mar. 26, 2021
BOOKS AND CHAPTERS RELATED TO YOUR RESEARCH	(Book Title, Chapter Title, Authors, Submission Date, Publication Date, Volume #, Page #s)
PUBLIC PRESENTATIONS YOU MADE ABOUT YOUR RESEARCH	(Event, Presentation Title, Presentation Date, Location)
AWARDS OR RECOGNITIONS YOU RECEIVED FOR YOUR RESEARCH PROJECT	(Purpose, Title, Date Received)
INTERNAL COLLABORATIONS FOSTERED	(Name, Organization, Purpose of Affiliation, and Frequency of Interactions)
EXTERNAL COLLABORATIONS FOSTERED	(Name, Organization, Purpose of Affiliation, and Frequency of Interactions)
WEBSITE(S) FEATURING RESEARCH PROJECT	(URL)
OTHER PRODUCTS AND SERVICES (e.g., media reports, databases, software, models, curricula, instruments, education programs, outreach for ND Energy and other groups)	(Please describe each item in detail)

RESEARCH EXPERIENCE

Please let us know what you thought of your research experience: Did this experience meet your expectations? Were lab personnel helpful and responsive to your needs? What else could have been done to improve your experience or achieve additional results?

My experience at the Neretina Nano-Fabrication Laboratory ignited my curiosity about the inner workings of the world through the nanoscopic scale. This research pushed me to ask more questions and strive to find the answers through experimental data. The topic was fascinating and highly relevant to many issues that we face today in the nano-manufacturing industry. The lab members were very encouraging and helpful throughout my journey with them during the spring semester of 2021.My research experience at the Neretina Lab has been immensely rewarding and educational.

FINAL WRITTEN REPORT

(Please use the space below to describe your research project and objectives, any findings and results you can share, and graphs, charts, and other visuals to help us understand what you achieved as a result of this research experience.)

Since nanomaterials with a single-crystal character provide ideal building blocks for on-chip plasmonic devices , control over all aspects of their fabrication is key for this technology to be applied for different applications in the nano- manufacturing industry. Although colloidal methods have demonstrated mastery over the synthesis of such structures, it has proven quite difficult to deploy these same nanomaterials on substrate surfaces in a highly deterministic manner where precise control over position and orientation is ensured. Herein, we demonstrate a room-temperature two-reagent liquid-phase seed-mediated synthesis of gold nanoplates directly on substrate surfaces in arrays over a square-centimeter area. The synthesis is reliant on benchtop lithographic and directed-assembly processes that give rise to single-crystal seeds of gold that express both an epitaxial relationship with the underlying substrate and the internal defect structure required to promote a two-dimensional growth mode. The resulting structures are highly faceted and, because seed-substrate epitaxy is imposed upon the growing nanoplates, are identically aligned on the substrate surface. Nanoplate yields are increased to values as high as 95% using a post-processing sonication procedure that selectively removes a small population of irregularly shaped nanostructures from the substrate surface, and in doing so, gives rise to an uncompromised plasmonic response. The work, therefore, advances the techniques needed to integrate single-crystal nanomaterials with wafer-based technologies and provides leading-edge capabilities in terms of defining large-area arrays of plasmonic structures with the nanoplate geometry.

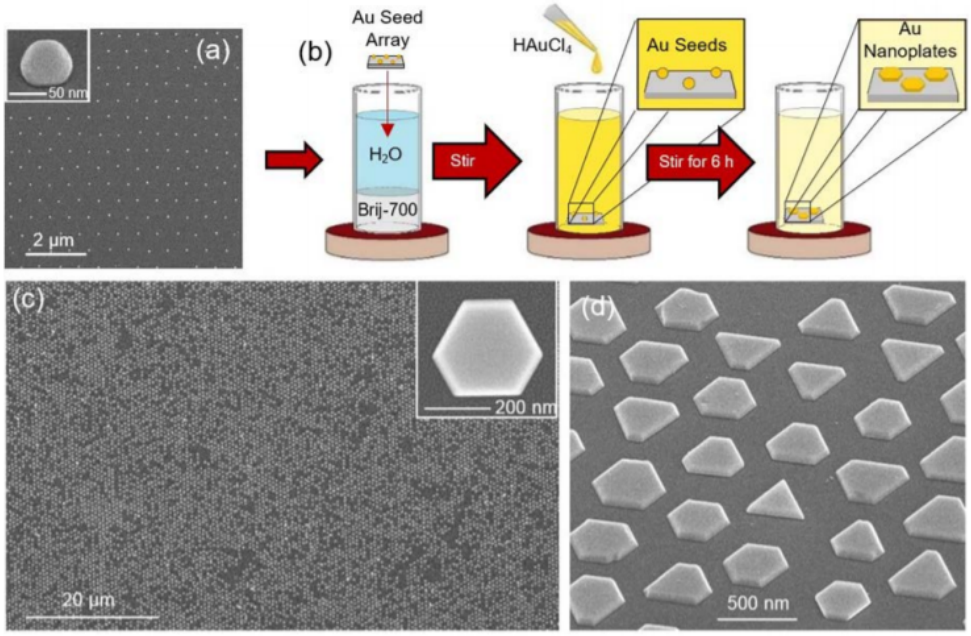

Figure 1.(a) SEM image of a periodic array of Au nanostructures that act as seeds for nanoplate growth. (b) Schematic representation of the solution-based Brij-700-directed nanoplate growth mode. (c) Low-magnification SEM image of a nanoplate array where the inset shows a top-view perspective of an individual structure. (d) Tilted-view image of nanoplates where neighboring structures exhibit parallel side-faceting due to a heteroepitaxial relationship between the Au seed and sapphire substrate.