Analysis of Semiconductor Layer Thicknesses Using an SEM

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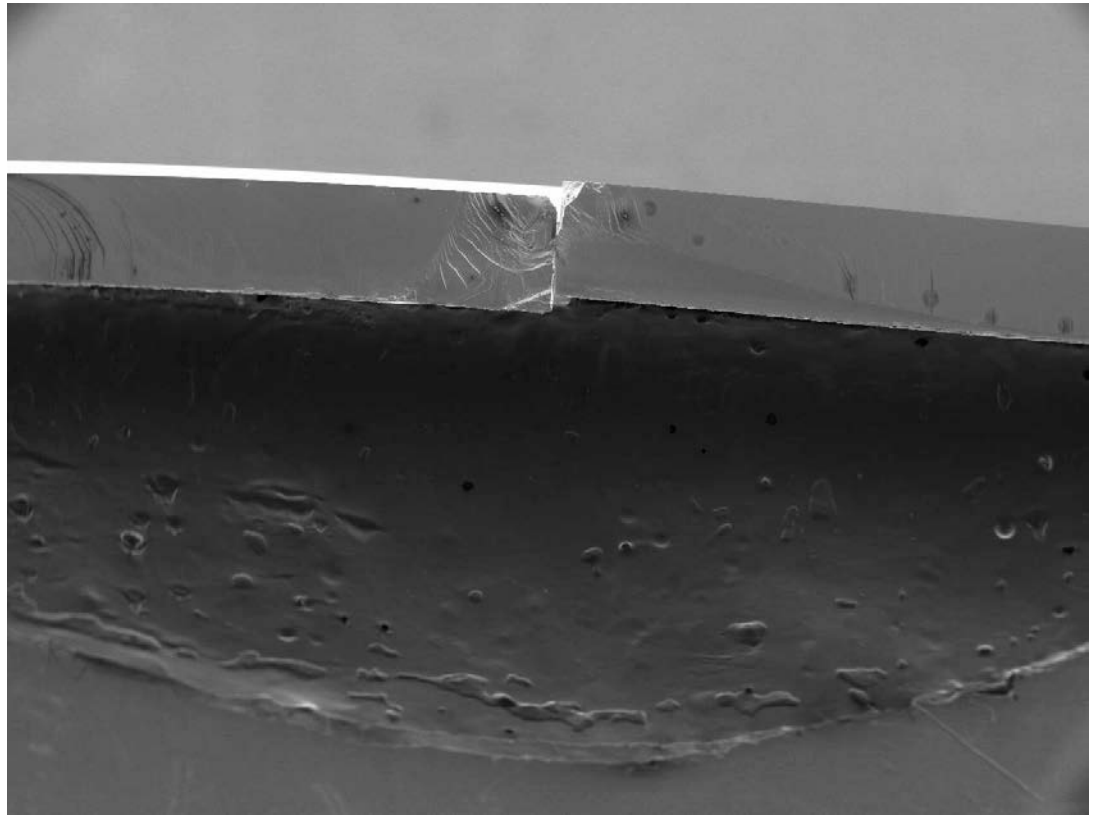
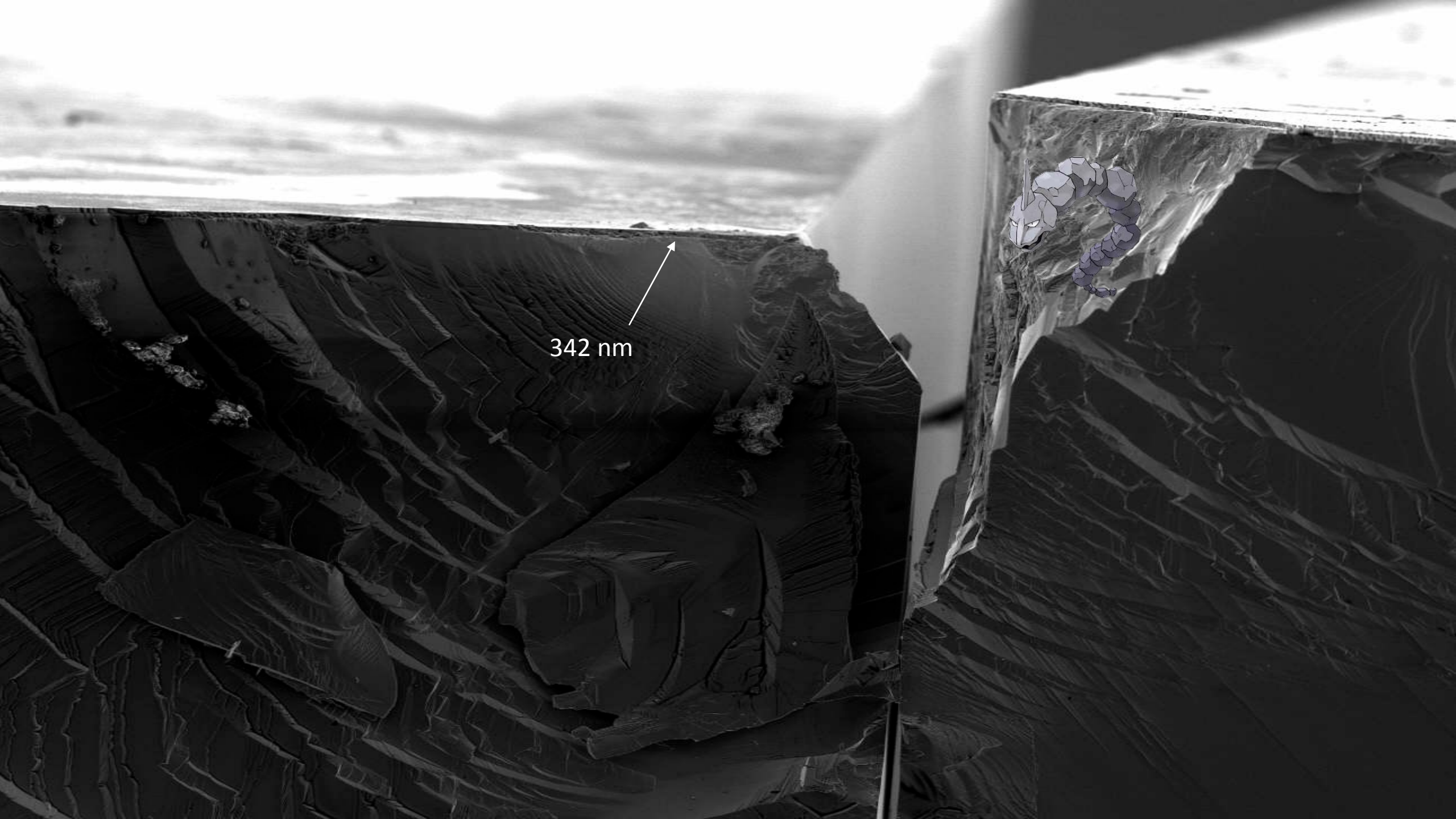
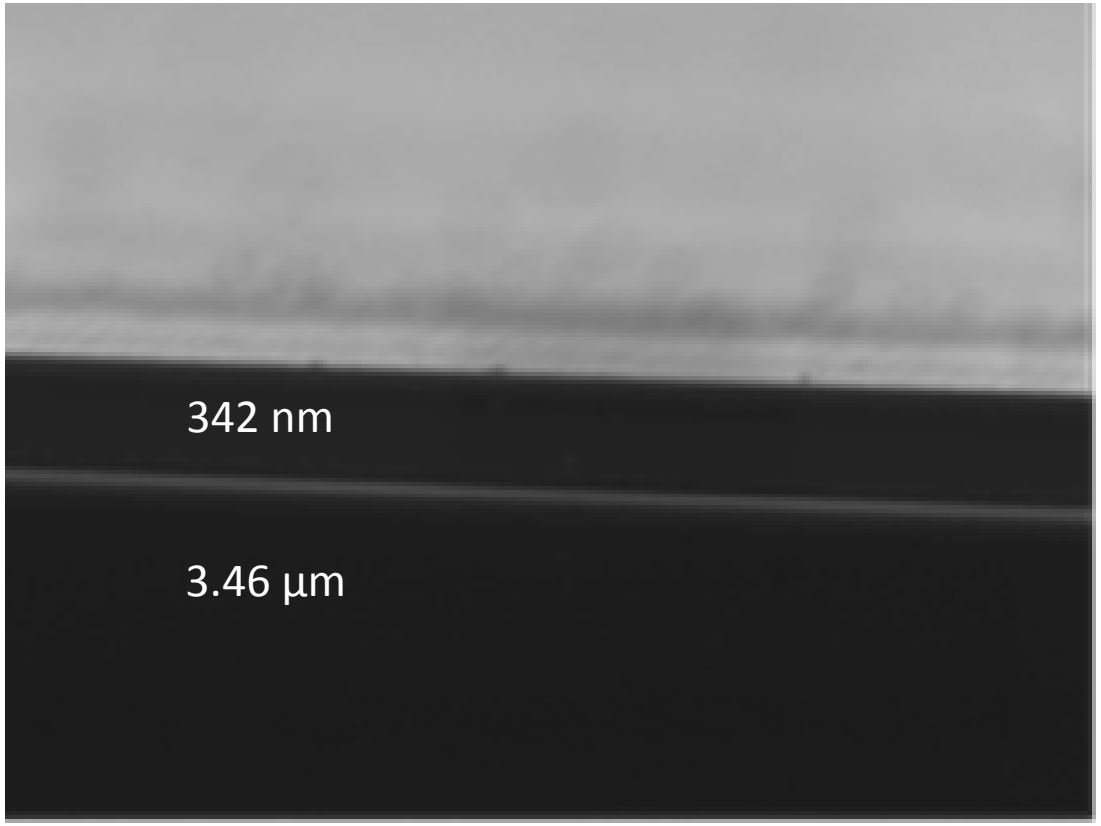
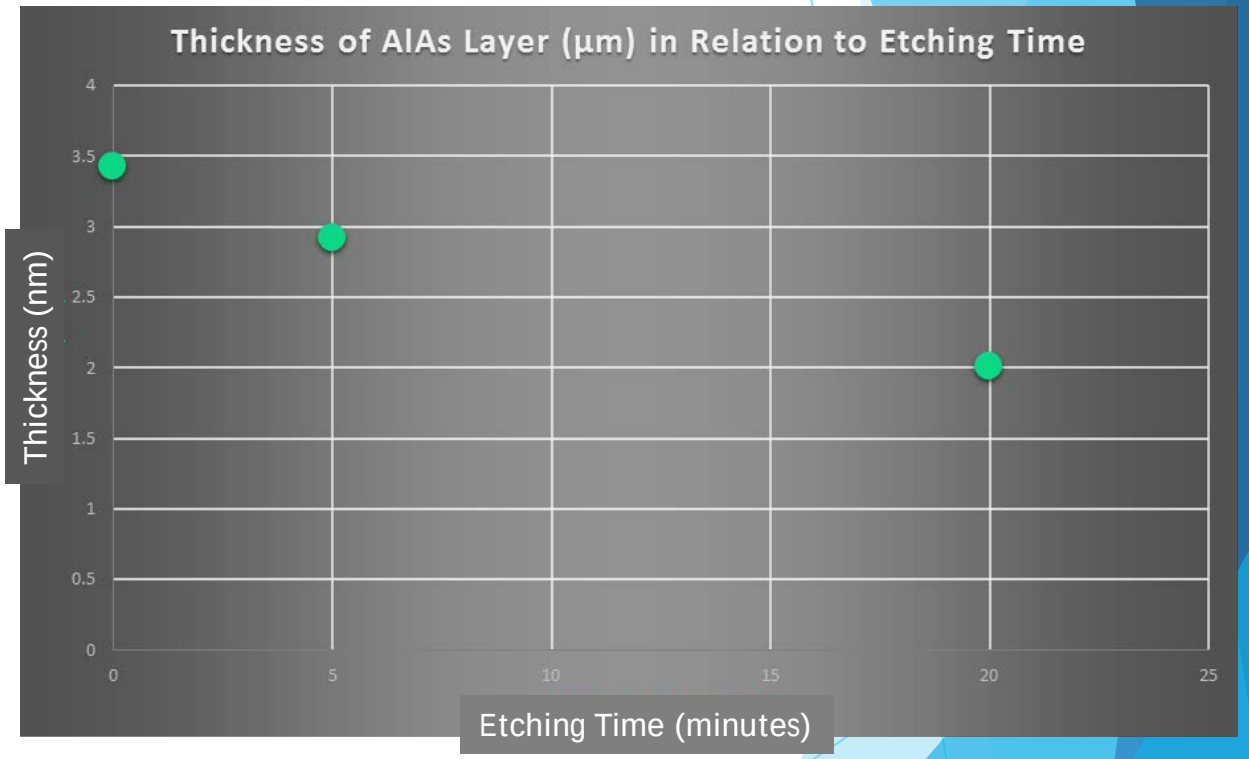
- Aluminum Arsenide oxidized to Aluminum Oxide
- Several samples
- All samples examined at a 90 degree angle to measure thickness from the side




342 nm


342 nm
3.46 µm


Thickness of AlAs Layer (µm) in Relation to Etching Time
Thickness (nm)
4
3.5
3
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
Etching Time (minutes)

MIRTHE16.m*

```
% initial prompt, asks user which method will be used
initial_prompt = ['Welcome. Would you like to calculate thickness at \n' ...
    'a single point or a range of thicknesses? Enter 1 for point, 2 for range, \n' ...
    '3 for further explanation, 4 to quit: \n'];
calc_type = input(initial_prompt);

% main if/else statement that takes user to desired calculation

if calc_type == 1 % point calculation
        %prompt for desired thickness
        prompt1 = 'Enter the desired end thickness point: ';
        end_thickness = input(prompt1);
        % equation below
        original_thickness = end_thickness + 1;
        if original_thickness > 0
            display(original_thickness)
        else
            display('ERROR: Input yields negative result, enter different number.')
        end

elseif calc_type == 2 % range calculation
        %prompt for range
        prompt2 = ['Enter a range in this format - [x:y:z] - If you do not \n' ...
            'know what the variables mean, enter 1 (WARNING: May yield \n' ...
            'negative results): '];
        end_thickness = input(prompt2);
        if end_thickness == 1 % if user wants help, goes here
            display('X is the starting number, Y is how much you wish to ')
            display('increment by, and Z is the ending number. For example, ')
            display('entering [4:2:10] will return an array that starts at 4,')
            display('ends at 10, and counts up by 2.')
            return;
        %equation below
        else
            original_thickness = end_thickness + 1
        end

elseif calc_type == 3 % explanation - may be removed
        display('explanation coming soon')
        return;

elseif calc_type == 4 % program exit
        display('Exiting the program.')
        return;

else % error message if other number is enetered
        display('ERROR: Invalid number')
        return;

end

```

Analysis of AlAs Layers Before and After Oxidation Via SEM

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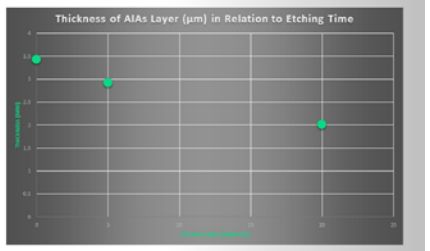
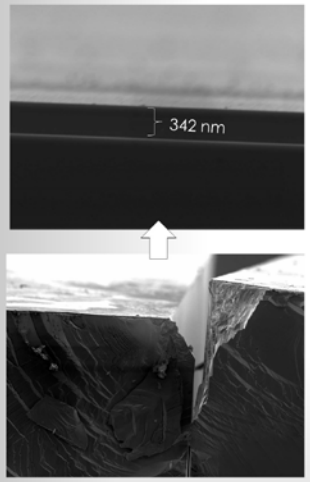
Nonlinear optical processes have various important roles in photonic applications. However, since bulk media does not display strong nonlinearities, the nonlinearities must be enhanced by using optical resonators known as microcavities to confine light for longer periods of time. Through a unique technique proposed by Z. Lin et al. [1], these microcavities consist of Aluminum Arsenide (AlAs) layers that can be oxidized to create Aluminum Arsenide (AlAs) and Gallium Arsenide (GaAs) layers on a Gallium Arsenide wafer (GaAs).

- Purpose: determine the effect of oxidation on the AlAs layer and manipulate the data in order to determine a best-fit function showing the relationship between etching time and thickness
- From the data, the function was determined to be
  $y = 0.002x^2 - 0.1098x + 3.42$,
  Where x = etching time and y = thickness
- Additionally, the R^2 value equaled 1, signaling that the equation is a perfect fit for the data





- A MATLAB program would prompt the user to input a post-etching thickness that he or she desired
- The input can be a single value or a range of values, returning a single value or range of values, respectively
- These single values and ranges of values that are returned are the required thicknesses prior to etching or oxidation

From the graph and equation, it can be concluded that the AlAs layer experiences shrinkage when it is oxidized. Additionally, the function and the MATLAB program were proven to be accurate because the initial thickness was calculated when the final thickness was entered into the program.

** These authors contributed equally to this work*

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