Fortifying Glass

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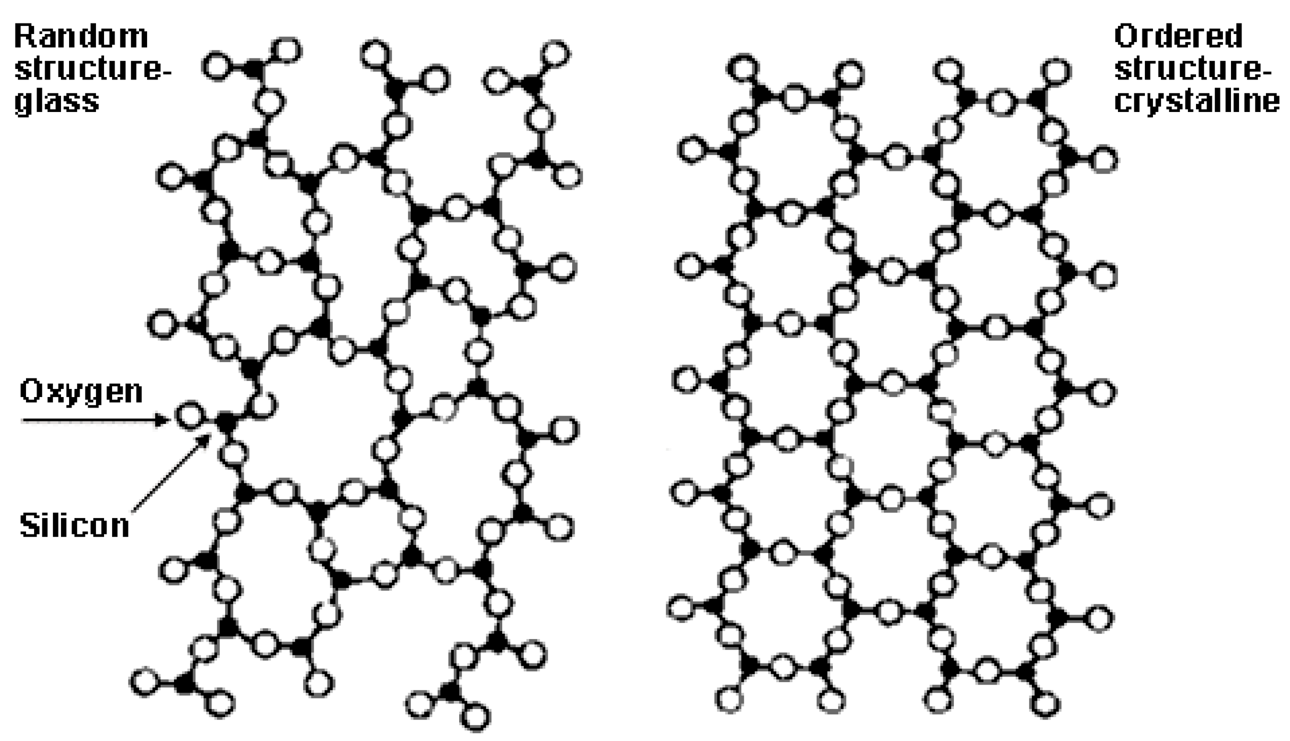
Introduction :

Glass and quartz are both made out of the same building blocks (Silicon dioxide). Glass is a very fragile material compared to quartz. The figure below shows the glass in its molecular form (on the left), and can be observed of properties as being highly random and unstructured compared to the quartz (on the right) which is highly ordered and structured.



(Note: the fourth oxygen for each tetrahedra is not shown)

Pure quartz is a transparent material just like glass, and it is much strong than glass, however it takes a lot of resources and time to make pure quartz. So why strengthen glass? Consider all the broken glass materials that may have remained intact if it was stronger. Some objects may include lab equipment, cell phones, windows, kitchenware, bottles, etc. Perhaps glass can be strengthened by making glass more structured and ordered with metal atoms to have it structured similar to quartz.

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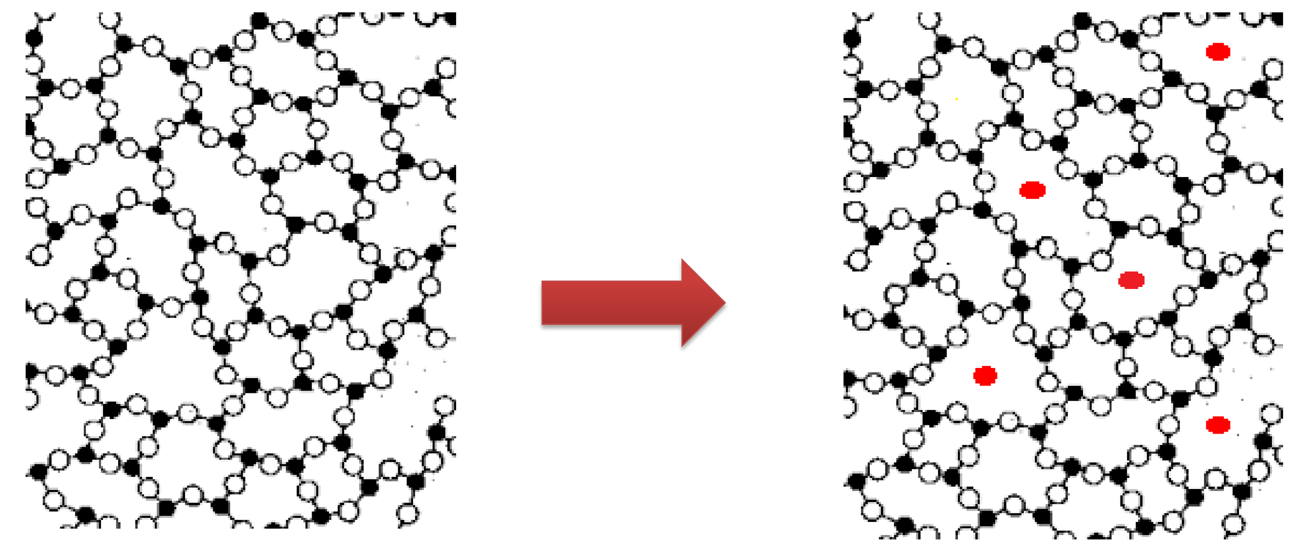
Methods :

1. Glass films are first doped with Cu, Zr, Al atoms.

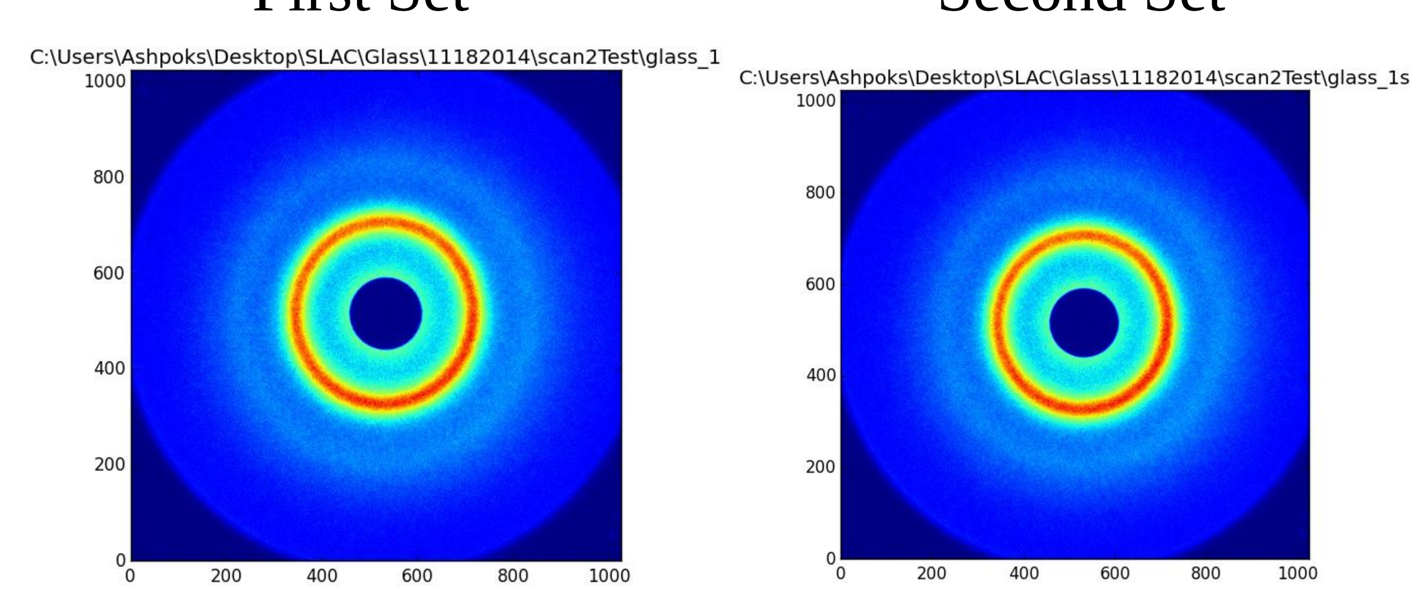


2. Two sets of experimental data were collected with thin glass films, the first was taken when the glass film is shot by a pump laser, and no pump laser is used for second set. The data was recorded by shooting electrons in both cases which produced electron diffraction patterns.

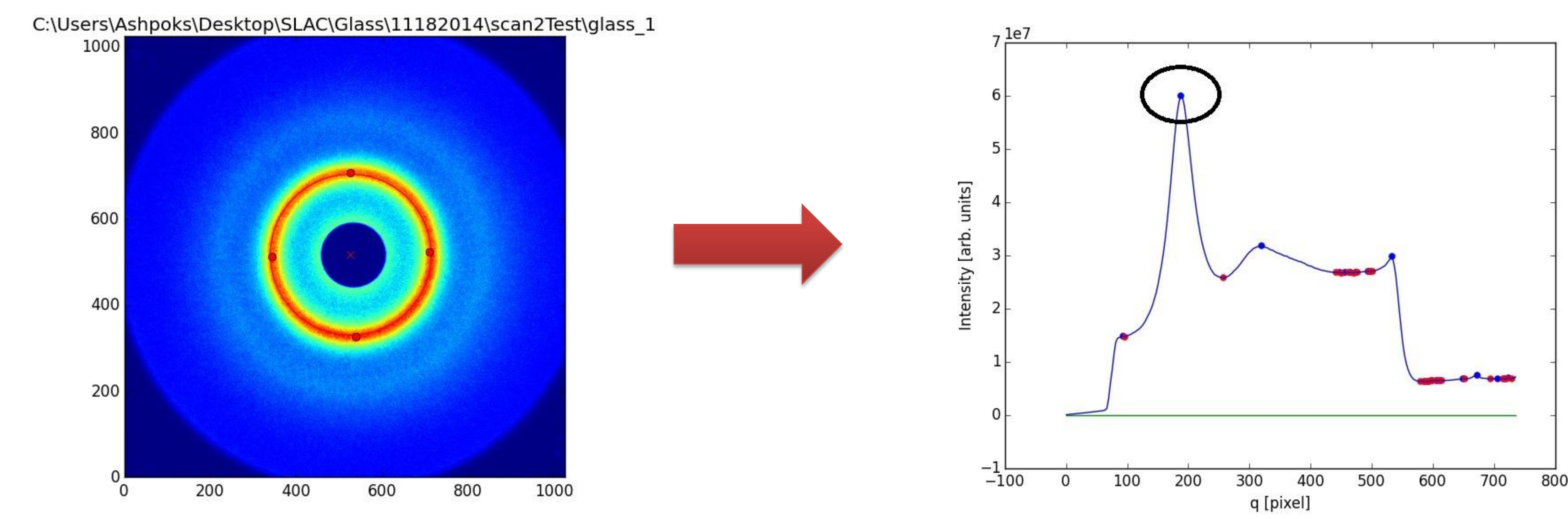
First Set   Second Set

3. The electron diffraction pattern is then recorded and each diffraction pattern is glass film in the reciprocal space, i.e. the momentum space. There are 50 diffraction patterns for each set.

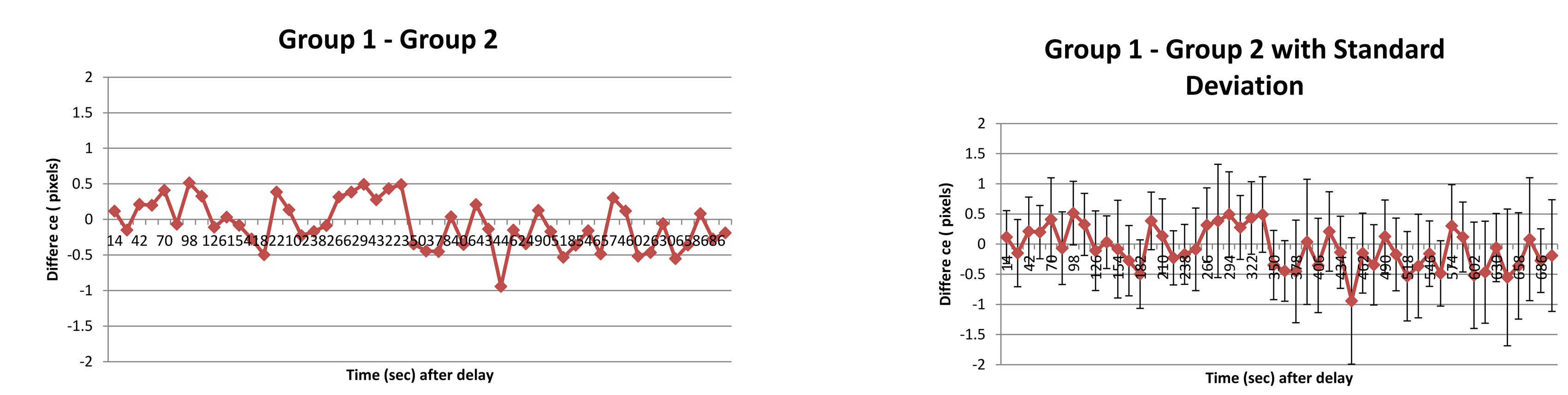
First Set   Second Set



4. The electron diffraction patterns from part three both appear to be identical hence further analysis is needed. The center of the ring is then estimated by manually selecting four points on the ring. The center is then defined with the artificial ring created. The center of the image, is where the measurement of the intensity of the electron diffraction pattern begins and ends at the edge of the image. The graph below on the right is generated and the one point circled is one of the data points. To account for finding the center error, the process was repeated ten times for each data point. Afterwards the average and standard deviation is taken.



There seems to be a sine like trend appearing from the resulting graphs shown below, however, when observing the graph on the right, the standard deviation bars are just too large.



In an attempt to reduce the standard deviation, 16 points were selected instead of 4, and seemed to have decreased the standard deviation by a factor of 1.84 with a standard deviation of 0.42 from comparing 10 different data points, following the same steps from part 4 in the methods section.

Conclusion :

The manual approach in determining the ring's center doesn't seem to be viable as it would consume too much time to determine the ring's center with a reasonable standard deviation. As a future goal another method to analyze the data would be an automatic center detection for the ring, which should remove any inconsistency of manually choosing the points, reducing the standard deviation. In addition to automatically detecting the center of the ring, doping glass with other metals with different compositions would also be another possibility to further the research.

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