

**FCUL**  
**Dispositivos Fotovoltaicos: materiais e tecnologia**  
**Assignment 2020**  
**PV FACTORY**

In this assignment you will be running a solar cell manufacturing line. You have to decide the right fabrication parameters to manufacture your solar cells.

To do the assignment you must use this website: <https://factory.pvlighthouse.com.au/>

**Objective:** The objectives of these assignments are to learn the importance of right parameters for good solar cell quality. Please work in the groups you formed for the lab session report.

1. BE SURE TO INCLUDE YOUR NAMES (WRITTEN CLEARLY) ON THE PAGE;
2. INCLUDE YOUR TEAM NAME AT THE TOP OF THE PAGE.

## Setting up your “Spec Recipe”

A “Spec Recipe” or Specification Recipe is a single master recipe that’s used by manufacturing operations during routine solar cell production. Currently, your Spec Recipe is set to be the PVF default recipe settings, and this recipe produces a relatively low-efficiency solar cell.

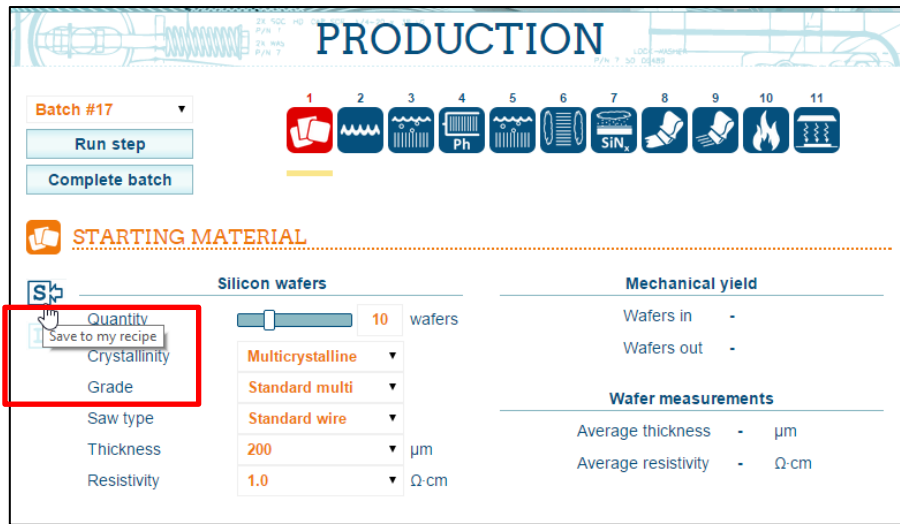
As we progress through the course, you will be discovering process improvements that you will want to incorporate into your Spec Recipe, so that future experiments can benefit from these improvements. Otherwise, your efficiency will not improve over time.

**Your Spec Recipe.** In the PVF, the Spec Recipe is called “My Recipe”. So, the first step is to set the PVF so it uses your My Recipe Spec Recipe instead of the PVF defaults.

1. Go to the menu **Office > User Settings** and where it says “Default input values when starting a new batch” select “Use My Recipe”

Now, when you start a new batch, the PVF will automatically load in the values that you’ve previously saved for your Spec Recipe.

**Saving/Loading to your Spec Recipe.** You can save the current PVF recipe settings into your Spec Recipe by clicking on the S-arrow located to the left of the screen on the Production screen, as shown below. You can also load your Spec Recipe into the current PVF recipe settings by clicking the R-arrow (just below the S-arrow icon.)



2. Set the Crystallinity to “Multicrystalline” and save this new setting to your Spec Recipe. Change it back to “Monocrystalline” and load your Spec Recipe (it should change back to “Multicrystalline” since that was the last-saved setting).

### Managing your Team’s Spec Recipe.

Agree with your teammates how you will manage your team’s Spec Recipe.

## Assignment 1 – Establish the Baseline

“The Baseline” refers to the normal operating conditions of the factory under the Spec Recipe. So, if we refer to the “Baseline Efficiency,” that would refer to the efficiency that results from using the Spec Recipe in normal manufacturing conditions. Since we are just getting started, this the control refers to the “default settings” in the PVF software, which have already been saved into your My Recipe.

Be sure to set the PVF so it’s using your Spec Recipe (choose Use My Recipe as explained in Setting up your “Spec Recipe” above).

We want to observe batch-average Efficiency.

### Conduct a Baseline Evaluation

1. Create and process 10 new batches using your Spec Recipe. Note the batch-average Efficiency of each of the 10 batches.
2. Enter the data into Excel (or similar spreadsheet software) and compute the average (=AVERAGE()) and standard deviation (=STDEV()).
3. Report your average and standard deviation on the classroom board. (Yes, we’re taking an average of Average Efficiency, and likewise for standard deviation.)

**SUBMIT:** Report your batch-average and batch-standard deviation for the 10 batches.

## Assignment 2 –Wafer Thickness

In this experiment, we will check to see if wafer thickness is an important “factor” that influences the “response” of batch-average efficiency. A “factor” is something we deliberately influence in an experiment (also known as the “independent variable”) and “response” is the attribute that we observe (also known as the “dependent variable”). We hope to use thinner wafers because they are potentially cheaper in the long run.

A “Split” is one of a series of treatments that comprise an experiment. This experiment has 4 splits, including the baseline split that you conducted in Part 2

## Conduct the Following Splits on Wafer Thickness

For each split, conduct 10 batches and compute the average and standard deviation of batch-averages..

1. Split 1: thickness = 200 microns (baseline, already completed in Part 2)
2. Split 2: thickness = 160 microns
3. Split 3: thickness = 180 microns
4. Split 4: thickness = 250 microns

### SUBMIT:

1. Summarize your findings on average of batch-averages in a suitable chart (scatter, variability, variability boxplot).
2. Did you observe any problems with yield at End of Line for any of the splits? If so, take a guess at reason for the observed problem with yield.

## Assignment 3 – Wafer Grade Wafers

In this experiment, we will test to see if the factor “Wafer Grade” has an influence on the response. Follow the step-by-step in Assignment 2, with the following recipe splits. Set your wafer thickness back to 200 microns.

For each split, conduct 10 batches and compute the average and standard deviation of batch-averages..

1. Split 1: Standard Cz (baseline, already completed in Part 2)
2. Split 2: High-performance Cz
3. Split 3: Float Zone

### SUBMIT:

1. Summarize your findings on average of batch-averages in a suitable chart (scatter, variability, variability boxplot).
2. Did you observe any influence of wafer grade on efficiency? If so, which wafer grade gives the best efficiency?

## Assignment 4 – Update your Spec Recipe

Decide on any changes you would like to make to your Spec Recipe, pertaining to thickness and wafer grade. Save your new Spec Recipe to your My Recipe settings by clicking the S-arrow button in the PVF Production page

**SUBMIT:** List all changes you made to your Spec Recipe

## Assignment 5 – Best Spec Batch-average Efficiency

Using your new Spec Recipe, run a few batches and observe the best batch-average efficiency you can achieve.

**SUBMIT:** Submit the best batch-average efficiency resulting from your new Spec Recipe.