

TLC 101

Thin Layer Chromatography is probably the most useful method to determine what is happening in a reaction (ex. Has it started?, Is it finished?, Has it stopped?, Do I have starting material left over?). It is also a nice method for gauging the purity of reagents and products.

What is TLC?

Read up on TLC! I'll give you the poor man's description here.

Solvent runs up a plate because of **capillary action** (read about this). When you spot a plate, you deposit a compound on the silica gel (**stationary phase**). As the solvent comes over the spot, some of the compound goes into solution above the silica gel surface (into the **mobile phase**). There is equilibrium between the compound going into and coming out of the mobile phase. In the mobile phase it gets carried up with the solvent. In the stationary phase, it doesn't. Because different compounds have different solubilities, molecular weights and interaction with the silica gel, they tend to have different equilibria. Under the same conditions (solvent, time, etc.), therefore, they will move differently on a plate.

What use is TLC

In the opening paragraph above, I mention some uses. Here are some practical examples.

Example 1: You are running a reaction to make a phosphonium salt. You let the reaction heat for three hours. You take a TLC and see some product, but you also see some big spots for P(Ph)_3 and your bromide. After 8 hrs., you take another plate. The spots for the starting material are smaller now. You let the reaction go 10 hours and see a spot only for P(Ph)_3 . Without the bromide, the reaction isn't going anywhere, so you might as well stop it. If you scale up the reaction next time to make five times as much, how long will the reaction take? It's hard to say, that's why you will have to monitor it by TLC.

Example 2: You have made a phosphonium salt and recrystallized it. You get a melting point, but it seems to be about 10°C lower than the literature value. A TLC may tell you if there is an impurity in it and what it might be.

There is often nothing worse than getting rid of unreacted starting materials when working up a reaction. Someone once said 'most reactions work, but the tough part is getting the product out'. This is very true. Your reaction can give a half-a-dozen different products and a TLC can give you an idea if the impurities are polar, non-polar, minor or major. Most importantly, TLC is like a model system for other chromatographic methods which can help you actually get your compound out from a complex mixture.

How do I go about choosing a solvent system?

There is no “right” solvent system. No one cares what you use, as long as it does the job. Here are some considerations:

- Mixed systems are nice because their polarity is easily adjustable.
- Some combinations won't work because the two solvents you want to use are not miscible.
- Stay away from toxic, expensive or unpleasant solvents.

When you know more organic chemistry, you will be able to judge the polarity of the compounds you want to separate on TLC. In general start from less polar (hexane) to more polar (ethyl acetate).

The bottom line is this: you need to be able to tell if the sample you're looking at is one thing or several things. If you see only one spot, but there are actually three compounds in the sample, you don't have a good system.

Why should the R_f be about 0.5?

Consider:

- if your spot doesn't move, it hasn't gone into the mobile phase and you can't hope to begin to separate anything.
- if your spot moves with the solvent front, the solvent may be so polar for the types of compounds you are dealing with, that everything is being carried up.

If you can see something with an R_f of 0.5 you have some indication that you're probably in the right polarity ballpark. You should be able to see things more polar (ahead of it) and less polar (behind it).

Some spots contain a mixture of polar and non-polar species. If you see something stuck at the origin (or a very dark solvent front) under the U.V., as well as the spot you expect in the middle of the plate, there might actually be several compounds in your sample.

When do I use iodine (I_2) on my plates?

Try it when working with new compounds. It may show up spots (or show them differently) than a UV lamp. It may also miss some.

TLC Tips and Tricks

Multiple Elutions

If you are trying to separate very close spots, try this. Use a less polar solvent system than you would normally use so that the spots only move a small distance up the plate. Remove the plate, let it dry a bit and then develop elute again. If you have a 2-inch plate and you do this twice, the solvent has moved almost 4 inches and at the end the spots will look as if you had used a three to four inch plate. Remember, the longer the plate, the easier it will be to see differences in R_f .

Co-spotting

Often times when you are monitoring the progress of reaction by TLC, you can have difficulty because the reference spots are applied in a pure solvent, whereas those from the reaction mixture may have other materials. To insure that your TLC spots are in the same environment, try co-spotting the reference sample and the sample under question.

Spotting

Applying the sample with a few quick dabs especially with a puff of air after each dab, helps to keep the spot small and well defined.

Two-dimensional Chromatography

This takes some time and usually requires you to cut new plates or get a different chamber, but it's great for separating hard to separate spots. After you elute the plate in one direction, dry it a bit and then turn in sideways and elute it again.

Other Developing Agents

There are lots of ways to see or develop spots on a plate. Some are more useful for aromatics, some for carbohydrates. If one way doesn't work, there are plenty of others to try and even more to invent.

Reverse Phase Chromatography

Using reverse phase plates, everything except the flow of the solvent is backwards: polar compounds move faster than non-polar and the more polar the solvent the less things move up the plates.