

Tollen's Test (Silver Mirror)

Description: An aldehyde is oxidized by silver (I) to generate a carboxylic acid and silver metal, which coats the surface of the glass vessel.

Materials:

0.1 M AgNO₃
0.5 M Dextrose
Conc. HNO₃
Conc. NH₄OH

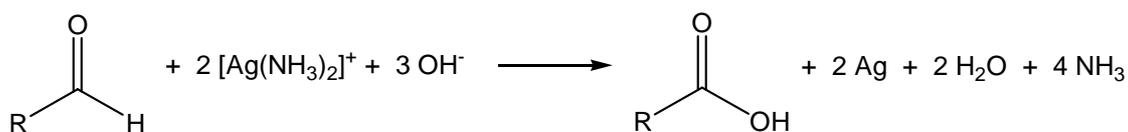
0.8 M KOH
Large test tube/rubber stopper
Beaker
Deionized water

Procedure:

This demonstration is best performed using a document camera.

1. Clean the test tube to be used by rinsing with concentrated nitric acid and washing well with hot water.
2. Prepare Tollen's reagent as follows: Add 50 mL of 0.1 M AgNO₃ to the beaker and add NH₄OH to this. A brown precipitate will form. Continue adding NH₄OH until the solution becomes clear. To this, add 25 mL of 0.8 M KOH. Again, add NH₄OH until solution becomes clear.
3. To perform demonstration, add 5 mL of dextrose solution to the test tube and to this add 25 mL of Tollen's reagent. The solution will turn yellow and brown then become cloudy and dark before silver begins to form on the inside of the test tube. This should take a couple of minutes.
4. Remove the contents from the test tube and rinse the tube with water. The tube with a "silver mirror" can now be passed around for the audience to observe.

Discussion: The Tollen's test is used in organic chemistry to test for the presence of aldehydes. In this reaction, an aldehyde is oxidized to a carboxylic acid while the Ag¹⁺ is reduced to silver metal, which deposits as a thin film on the inner surface of the glass. The generic reaction is as follows and is specific for aldehydes:



Safety: Wear proper protective equipment including gloves and safety glasses when preparing and performing this demonstration. Concentrated nitric acid will cause burns and is a strong oxidizing agent. Potassium hydroxide (solid or concentrated solutions) can cause burns. Silver nitrate is toxic if ingested and may stain the skin. Concentrated ammonia is an irritant to the skin and respiratory system and should only be handled in a fume hood.

*THE RESULTING AQUEOUS SILVER SOLUTION SHOULD BE DISCARDED AFTER USE AS THESE SOLUTIONS HAVE THE POTENTIAL TO GENERATE HIGHLY EXPLOSIVE SILVER NITRIDE PRECIPITATES.

Disposal: Resulting solutions from reactions with aldehydes can be flushed down the drain with plenty of water. Demonstrations using ketones should be discarded in an appropriate waste container. Silver can be recovered by washing the test tubes with 1 M HNO₃ and evaporating the acid.

References:

Shakhashiri, B. Z. In *Chemical Demonstrations: A Handbook for Teachers of Chemistry*; The University of Wisconsin Press: 1992; Vol. 4, p 240-243.

Silversmith, E. F. *J. Chem. Educ.* **1988**, 65, 70.

Ennis, J. L.; Shanley, E. S. *J. Chem. Educ.* **1991**, 68, A6. (silver nitrides)

Video:

<http://www.youtube.com/watch?v=zFMsqcGdZCc>

<http://www.youtube.com/watch?v=oKETXMWtkBE>

<http://www.youtube.com/watch?v=11h3mFyMn84>