Microwaves

Mindfulness Minute: Incorporate safety into your workflow by considering the hazards associated with your equipment each time you use it.

Microwaves heat substances in a fundamentally different way than traditional methods of heat transfer (conduction or convection). Despite their convenience, there can be physical and chemical hazards associated with using microwaves in the lab. Knowing how chemicals react to microwaving, the features and limitations of your microwave, and how microwaved substances behave is critical to safely using microwaves in the lab.

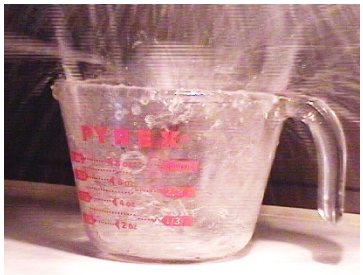
Lab grade microwaves have important ventilation and fire safety features:

Household Microwave: 	• When flammable or combustible materials are heated, and the temperature nears the flash point, fire or explosion is more likely. • When flammable liquids are heated in a closed area, the vapor concentration increases and may exceed the lower flammable limit. • The electrical wiring can provide an ignition source. • When hazardous chemicals are heated in a microwave, employees will be exposed to higher than usual vapor concentrations when the device is opened. • Microwave ovens that are not explosion-proof do not conform to NFPA 45 and are considered to be ignition sources.
Laboratory-Grade Microwave: 	Designed to eliminate possible ignition sources, detect solvent leaks, and remove vapors. Safety features include: • Exhaust fan: evacuates the air in the cavity approximately once per second. • Airflow switch: shuts down the system if the exhaust fan fails or there is a block downstream of the fan. • Solvent detector: monitors the cavity for the presence of solvent. Shuts system down and alarm if solvent concentration is tenfold below the LEL concentration in air for the solvent.

Different chemicals react to microwaves differently: some chemicals absorb microwaves whereas others do not, leading to temperature differentials in the reaction mixture. Consider what is known for all reactants, products, and solvents before heating them in a microwave. Unknown samples and unintended products could produce unexpected effects when microwaved. The microwave radiation or the heating process itself may act on chemicals to produce unexpected, hazardous chemical by-products.

Liquids, including water, heated in a microwave can greatly exceed their conventional boiling points due to superheating. Superheated liquids are unstable, hotter than they appear, and can spontaneously boil and produce steam.

Traditional heat transfer using convection or conduction allows a steady temperature to be reached and maintained, whereas there is no way to regulate or monitor temperature or stir contents to distribute heat while using a microwave. This is especially hazardous when exothermic reactions are taking place.



Superheated liquids can boil so suddenly and violently that the liquid is ejected from the container.

References:

Foster, B.L., Cournoyer, M.E. (2005). The use of microwave ovens with flammable liquids. *Chemical Health and Safety*. https://doi.org/10.1016/j.chs.2005.01.015.

https://www.osha.gov/laws-regs/standardinterpretations/2002-08-08-0