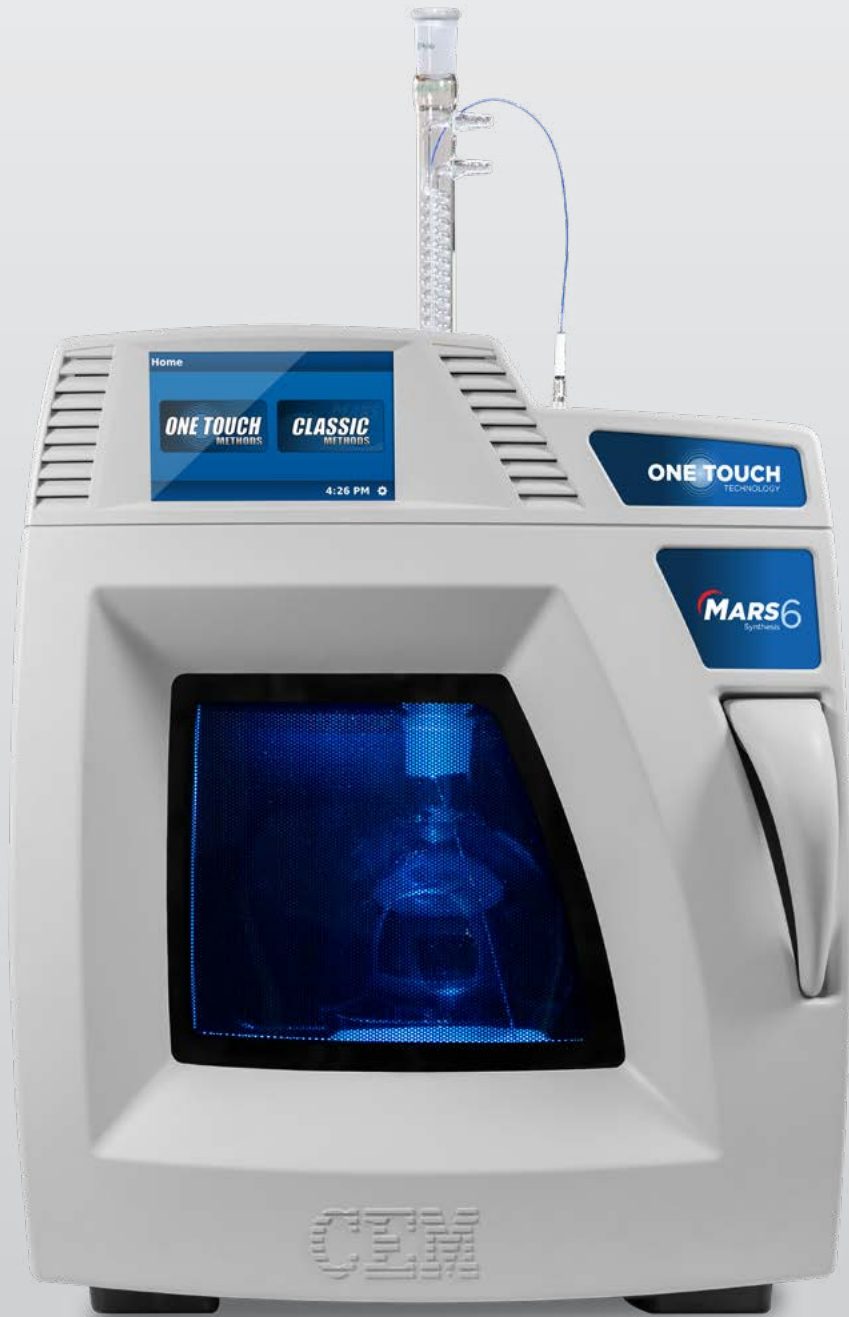




## MARS 6™ Synthesis

Parallel & Scale-Up Microwave Synthesizer



# Parallel Synthesis Made Easy

The MARS 6 Synthesis is a multi-mode microwave system that provides parallel reaction processing, under uniform conditions. The ability to run multiple reaction vessels simultaneously is advantageous for large laboratories, as it only takes 30 minutes to complete a set of 36 vessels. With the ability to accommodate multiple pressurized vessels, or up to a 5 L open flask, the MARS 6 Synthesis offers both high throughput for larger labs and flexibility to run batch syntheses.

## Conventional Heating

**18**  
hours

VS

## Microwave Heating

**1.75**  
hours



### Construction

#### Steel Cavity

Solid steel cavity construction, using industry leading 316 stainless steel for durability.

#### Spring Mounted Door

A heavy-duty spring mounted door that will automatically relieve any pressure from a vessel event.



### Software

#### Compliant Software

Software is 21 CFR Part 11 compliant for electronic records and signatures.

#### Data Storage

The 8 GB of storage provides more than enough data storage for the lifetime of the system.



### Safety Protocols

#### Temperature Control

The MARS 6 Synthesis automatically limits the temperature to a safe range and adjusts as needed.

#### Reactiguard™

The Reactiguard cavity sensing device automatically turns off the system if a vessel event occurs.



### Ease of Use

#### Touch Screen

7-inch glass capacitance, high definition display provides onboard control for method programming and on-demand training videos.

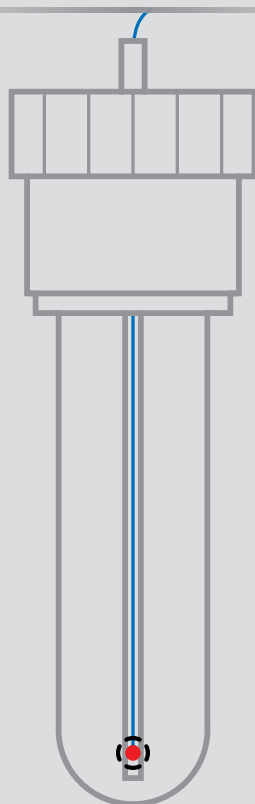
#### Flexible Vessel Configuration

Perform a variety of reactions at a wide range of scales using specialized vessel sets.

## Intuitive Software

# Simple, Fast Reaction Programming

Designed to make microwave synthesis virtually effortless, the intuitive MARS 6 Synthesis software features guided method programming for user-defined control. During the run, temperature, pressure, and power graphs are displayed in real-time on the built-in touchscreen. Training videos can be accessed directly from the touchscreen to educate new users on proper vessel assembly, system operation, and maintenance. Reactions, run data and methods can be recalled easily and exported onto a USB drive or printed from the built-in printer option.



## Precision

# The Most Accurate Temperature Control Available

Fiber-optic temperature control provides the most precise temperature measurement available, by directly measuring the temperature inside the reaction vessel. Electromagnetic stirring helps to ensure maximum agitation for your reaction mixture. Adjust the speed to guarantee your sample mixes each and every time no matter the reaction.



Create Method

Stage	Ramp	Hold	Temp	Power
1	15.00	0:30	105	600
2	15.00	0:30	100	600
3	10.00	0:30	100	580

Exit Stage Parameters →

2:08 PM ⚙

CLM

# One Instrument, Many Possibilities

The MARS 6 Synthesis microwave provides educators and researchers with a safe and simple to use tool for parallel reaction processing under uniform, reproducible conditions. Perform reactions safely at higher temperatures with shorter reaction times, leaving more time for teaching and less time waiting in the lab! The flexible vessel sets can accommodate a wide range of academic class sizes and reaction scales for virtually any syntheses.

- Teaching Laboratories
- Organic Synthesis
- Inorganic Chemistry
- Nanomaterial Production
- Polymer Synthesis
- Scale-Up Production
- Acid Digestion for Metals Analysis
- Solvent Extraction



	EasyPrep™ Plus & EasyPrep™	Open Vessel	MARS XPress Plus
Minimum Ramp Time	• 5 minute (EasyPrep™ Plus) • 20 minute (EasyPrep™)	5 minute	5 minute
Maximum Number of Vessels	12	1	16
Maximum Working Volume (per vessel)	75 mL	70% of Flask Volume	75 mL
Minimum Working Volume (per vessel)	20 mL	100 mL	20 mL
Maximum Control Temperature	300 °C	Reflux	210 °C
Temperature Control Type	Fiber Optic Probe or Fiber Optic Probe and IR (DuoTemp™)	Fiber Optic Probe	Fiber Optic Probe
Vessel	Teflon® TFM 1700	Standard Round Bottom	Teflon®
Thermowell	• Sapphire (EasyPrep Plus) • Teflon® TFM (EasyPrep)	Glass or PFA	Sapphire
<b>Ideal Chemistry</b>	<ul style="list-style-type: none"> <li>• Inorganic and material research (EasyPrep Plus)</li> <li>• Zeolite synthesis, other alkaline chemistry (EasyPrep)</li> </ul>	Organic and inorganic teaching laboratories, and large scale chemistry	Organic and inorganic teaching laboratories



**CLEAN,  
FAST  
ORGANIC  
CHEMISTRY**  
STUDENT EDITION

Microwave-Assisted Laboratory Experiments  
Nicholas Leadbeater, Ph.D. & Cynthia McGowan, Ph.D.

CEM We Simplify Science

**Microwave Energy**

Microwave irradiation is a form of energy that falls between 300 and 300,000 megahertz (MHz), relatively low on the electromagnetic spectrum. (Figure 1) Unlike ultraviolet radiation, which is used in photochemistry and can break chemical bonds, microwaves are low frequency forms of energy that only cause the molecules to rotate.

**Figure 1. The Electromagnetic Spectrum**

The energy of a microwave at a frequency of 2.45 GHz is 0.0001 eV (10<sup>-4</sup> eV). The average energies of some common chemical bonds are as follows:

- C-C single bond = 3.4 eV
- C-C double bond = 6.1 eV
- O-H bond = 4.5 eV

Like all electromagnetic energy, microwaves move at the speed of light and are perpendicular to each other, perpendicular to the direction of travel. It is primarily the electric field of the microwaves which causes the transfer of energy and the generation of heat.

**Figure 2. A Microwave**

The Arhenius equation is a simple, yet very accurate predictor of the reaction rate.

Compared to using a hotplate to heat a reaction mixture, microwave irradiation is much more efficient and greatly reduces the reaction time. The hotplate relies on thermal conductivity and convection currents to heat the reaction mixture, and then pass through to the reactants. Microwave energy interacts directly with the molecules in the reaction mixture, heating the reactants much faster than conventional methods. With microwave irradiation, since the energy is interacting with the molecules at a very fast rate, the molecules do not have time to relax and the heat generated can be, for short periods, much greater than the overall received temperature of the bulk reaction mixture. In essence, there will be instantaneous localized superheating. (Figure 5)

**Figure 5. Localized superheating of molecules in solution.**

The rate of a reaction is described by the Arrhenius equation, which expresses the relationship between the rate of reaction and the activation energy,  $E_a$ . (Figure 6)

**Figure 6. Arrhenius Equation**

$$k = Ae^{-E_a/RT}$$

The activation energy is the energy barrier that must be overcome in order for the reaction to occur. A microwave transfers energy to the reaction every microsecond (10<sup>-6</sup> seconds). The almost constant energy input is achieved at a rate greater than



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