

CEM is the leading provider of microwave laboratory instrumentation. We have been designing and building award-winning systems for 25 years. As pioneers in the field of microwave chemistry, we have developed many of the official microwave-based methods used by internationally recognized organizations. CEM systems are the only ISO 9001:2000-approved microwave systems available worldwide. Our chemists have published articles on a number of different applications and a senior scientist at CEM wrote the first book on the subject of microwave synthesis. The ability to conduct sub-ambient temperature reactions in a microwave system is just another way this industry-leading team of chemists continues to push beyond the boundaries of conventional processes. At CEM R&D isn't just an acronym – it means pioneering Research followed by inventive Development!

Every CEM instrument is backed by a dedicated team of experienced chemists and technical service personnel ready to help you. Our commitment to you doesn't end when your system is shipped: it begins.

# CEM

*Innovators in  
Microwave Technology*

## Headquarters

**CEM Corporation**  
P.O. Box 200  
Matthews, NC 28106

Tel: (800) 726-3331  
Tel: (704) 821-7015  
Fax: (704) 821-7894  
e-mail: [info@cem.com](mailto:info@cem.com)  
web: <http://www.cem.com>

## Subsidiaries

**CEM Microwave Technology Ltd.**  
2 Middle Slade  
Buckingham Industrial Park MK18 1WA  
United Kingdom  
Tel: 011-44 1 280 822873  
e-mail: [info.uk@cem.com](mailto:info.uk@cem.com)

**CEM GmbH**  
Carl-Friedrich-Gauß-Str. 9  
47475 Kamp-Lintfort Germany  
Tel: 011-49-2842-9644-0  
e-mail: [info@cem.de](mailto:info@cem.de)  
web: <http://www.cem.de>

**CEM  $\mu$ Wave S.A.S.**  
Immeuble Ariane  
Domaine Technologique de Saclay  
4, rue René Razel  
91892 ORSAY Cedex France  
Tel: (33-1) 69 35 57 80  
e-mail: [info.fr@cem.com](mailto:info.fr@cem.com)

**CEM SRL**  
Via Dell Artigianato, 6/8  
24055 COLOGNO AL SERIO (BG) Italy  
Tel: 011-390-35-896224  
e-mail: [info.srl@cem.com](mailto:info.srl@cem.com)

# Discover<sup>®</sup> CoolMate

## *Low-Temperature Microwave Synthesis System*



# CEM

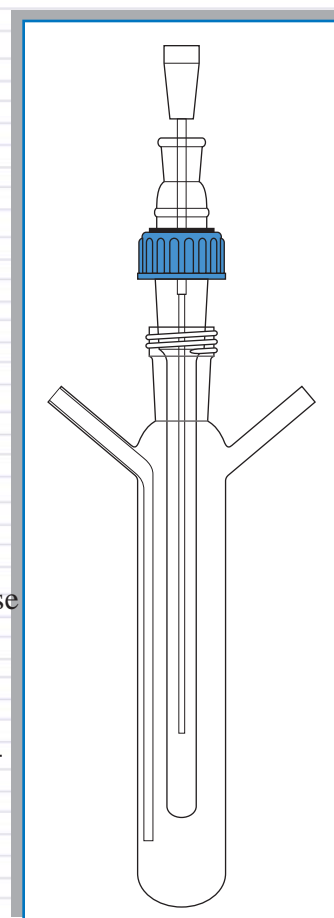
## Experience the benefits of microwave-enhanced reaction rates in a system designed for sub-ambient temperature synthesis.



Now, you can perform low-temperature reactions in a microwave synthesis system and still achieve the same rate enhancements commonly associated with high-temperature reactions. The new Discover® CoolMate™ System performs standard temperature-sensitive reactions including carbohydrate chemistry, formation of carbanions and other highly reactive intermediates, while giving you the security of knowing that your reactions are under constant temperature control. The system is also ideal for the safe use of highly reactive species in a microwave system, an area previously considered beyond the reach of microwave-enhanced synthesis.

- **Integrated cooling system assures the lowest temperature range possible with any microwave system**
- **Jacketed vessel design with removable reaction vials for convenience and easy setup**
- **Exclusive microwave-transparent cooling media**
- **Work with reaction volumes from 250  $\mu$ L –to 7 mL**
- **In situ fiber optic temperature monitoring**
- **Onboard reaction monitoring provides feedback for unattended operation**

CoolMate gives chemists access to new pathways in temperature-sensitive reactions, some of which cannot be produced under conventional conditions. Because microwave energy is transferred kinetically, not thermally, microwaves can accelerate reactions maintained at low temperatures. CoolMate's proprietary, jacketed reaction vessel and exclusive cooling media are both microwave transparent, insuring the full energy transmission directly to your reactants. The vessel and cooling technology keep the bulk temperature of the reactants low, preventing thermal degradation of the product. Temperature measurement is accomplished with an in situ fiber-optic probe to insure fast, accurate, and convenient reaction control.



## CoolMate Chemistries

Sub-ambient microwave synthesis is most effective for reactions that are temperature-sensitive or those that are slow to proceed, as in the following examples.

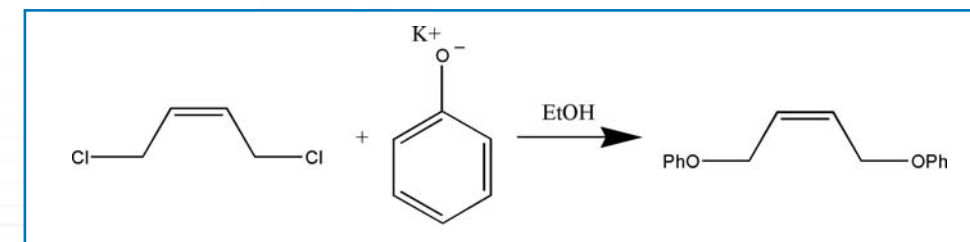


Figure 1. Diphenoxybutene Synthesis.  
Roversi, E.; Monnat, F.; Vogel, P.; Helv. Chim. Acta, 2002, 85, 733.

The cis isomer is the desired product in the substitution reaction between cis-1,4-dichloro-2-butene and a phenoxide anion in Figure 1. Conventionally, this reaction takes 21 hours. It is held for 6 hours at 0 °C, then it is allowed to warm to 20 °C and react for an additional 15 hours. Using CoolMate, CEM Chemists were able to accelerate the reaction by allowing it to proceed for 35 minutes at 30 °C. The microwave procedure achieved an 87% yield, favorably compared to the 75% yield conventionally. The formation of the cis isomer was confirmed.

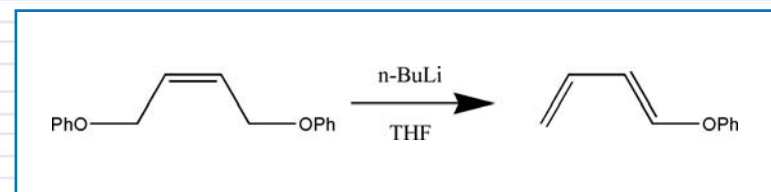


Figure 2. Phenoxydiene Synthesis.  
Roversi, E.; Monnat, F.; Vogel, P.; Helv. Chim. Acta, 2002, 85, 733.

Elimination reactions catalyzed by n-butyllithium typically necessitate room temperature, or lower, reaction conditions. Previously, these temperature limits prevented its use in a microwave. The reaction shown in Figure 2 illustrates how a reactive species, such as n-butyllithium, can be utilized in a microwave. To achieve a 78% yield conventionally, the reaction took 2.5 hours, ranging in temperature from 0 °C to 25 °C. Because the transfer of energy in a microwave is dependent on kinetic transfers and not on thermal energy, the transformation could be accomplished at -60 °C in 5 minutes with a yield of 81%.

CoolMate expands the range of chemistries that can now benefit from microwave enhancement. Designed using the versatile Discover® platform, CoolMate offers all of the ease-of-use and flexibility for which CEM Life Science systems are known, including fiber optic direct temperature measurement, complete programmable control of power and temperature, and the ability to use additional standard glassware. Intuitive software enables simple translation of conventional methods to microwave conditions and the robust, compact system fits into a standard fume hood.