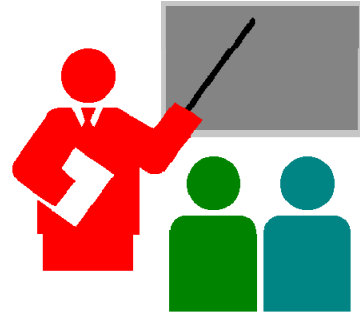


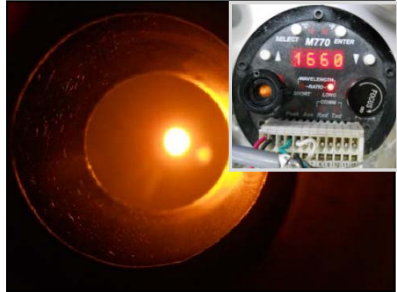

Microwave heating and accessory technologies used in the fabrication of advanced microwave vacuum furnaces constitute the core of Hadron Technologies' knowledge base. This includes the understanding of the physics involved in microwave heating as well as fundamentals and practical aspects of vacuum technology.

Background

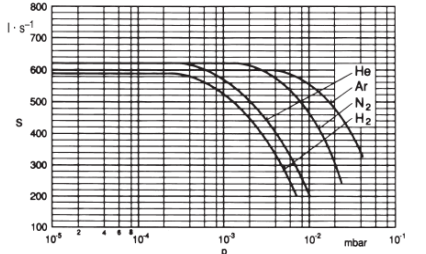

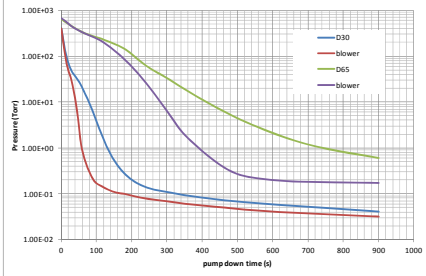
At Hadron we are constantly developing new materials and designs for systems and components to be used with microwave (MW) technology. In order to be able to do so we have accumulated expertise on several pertinent areas of knowledge and we would like to make this knowledge available to customers that have purchased our equipment. Training will be provided at Hadron's Colorado facility. Training at the customer's facility can also be scheduled, however, hands-on experience will be limited to equipment available and access granted by customer.



1. Microwave heating

Goal / Teaching aim:	Discuss the electromagnetic nature of microwaves and the heating mechanism of materials. Provide hands-on experience on operating a MW furnace.	$P_{av} = \text{Electric losses} + \text{Magnetic losses}$ $P_{av} = \omega \epsilon_0 \epsilon_{eff}'' E_{rms}^2 + \omega \mu_0 \mu_{eff}'' H_{rms}^2$
Equipment:	High-vacuum bottom loader microwave furnace equipped with optical pyrometer.	
Experiments:	Hands-on training on heating and melting of materials. Includes assembly of insulation stack, loading the furnace, applying power and tuning the system manually.	
Relevance:	Understanding principles of how materials interact with microwaves and practical aspects of operating a furnace are the main requisites to heating and melting materials using microwave energy.	
Period:	3 days	
Price:	Call for pricing information.	

2. Vacuum technology

<p>Goal / Teaching aim:</p>	<p>Provide an overview of vacuum fundamentals including definitions, symbols and units as well as to discuss the basic operation principles and practical aspects of vacuum sensors and pumping systems, including selection criteria.</p>	
<p>Equipment:</p>	<p>High vacuum chambers equipped with diffusion and cryopumps. Rotary vane, scroll and rootsblower pumps will also be discussed and operated. Convection type, capacitance manometers and ion gauges.</p>	
<p>Experiments:</p>	<p>Operation of the pumps, system pump down comparison using different pumps (see graph), operation of different types of sensors and common errors observed when used inappropriately.</p>	
<p>Relevance:</p>	<p>Understanding the fundamentals of vacuum and how the different types of pumps and vacuum sensors work not only helps on equipment selection moving forward but also will enable operators and general maintenance technicians troubleshooting and solve minor problems or take appropriate steps to have major issues solved.</p>	
<p>Period:</p>	<p>3 days</p>	
<p>Price:</p>	<p>Call for pricing information.</p>	

3. On-site training

<p>Scope:</p>	<p>On-site training can be provided to customers on systems previously purchased. Both courses (microwave and vacuum) can be bundled and contents can be tailored to accommodate specific needs.</p>
<p>Period:</p>	<p>3-5 days (defined prior to start of the course)</p>
<p>Price:</p>	<p>Call for pricing information.</p>



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