










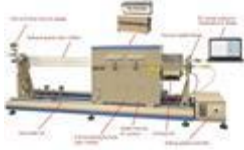








Table 1. Tabulated MTI Tube Furnace for Graphene and CNT Growth

No	Model	Working Tube Dia.	Heating Rate	Working Temperature	Features	Item Image
1	OTF-1200X-4-NW-UL	4.33" O.D x 4.05" LD x 29.13" Length quartz tube	Max: 20°C/min	Max: 1100 °C (<2 hr) Cont: 200-1000 °C	OTF-1200X-4-NW-UL is a compact 1100°C CVD tube furnace with a precursor sublimating attachment. Totally four-channel gas inlets are built on the sublimation which allows feedings of various gases to carry the source vapor into the main heater for further decomposition and deposition. The sample holder fixture mounted on the right flange is slidable for easy sample loading/unloading. Such a system configuration is suitable for growing a wide range of transitional metal dichalcogenides (such as MoSe ₂ , MoS ₂ ...) and wide bandgap semiconductors (such as h-BN) layers on substrate up to 3" diameter.	
2	OTF-1200X-III-RR	100 mm O.D three heating zone split tube furnace	Max: 10°C/min	Max: 1200°C (< 1 hr) Cont: 1100°C	OTF-1200X-III-RR is a lab-scale Roll to Roll graphene preparation tube furnace system, which contains 100mm O.D. three heating zone split tube furnace at 1200°C Max. and two vacuum chambers with substrate reeling in and out, as well as a touch screen control panel. The R2R system is designed for exploring the flexibility to grow graphene or other CVD films continuously for the industry.	
3	OTF-1200X-RTP-4-SL	Ø4.05" OD x 1400mm L	Max: 50°C/s	Max: 1000°C (<1 hr) Cont: 600°C	OTF-1200X-RTP-4-SL is an RTP (4" OD) furnace with Infrared Light Heating and Slide Cooling. It is capable of achieving a max. heating rate > 50°C/s and a cooling rate > 10°C/s. The furnace is designed for growing graphene and carbon nanotubes by CVD.	
4	OTF-1200X-4-RTP	4.33" O.D x 4.05" I.D x 16.2" Length	Max: 50°C/s	Max: 1100°C(<10 min) Max: 1000°C (<20 min) Max: 800°C (<120 min) Cont: 600°C	OTF-1200X-RTP-4 is a compact rapid thermal processing tube furnace with a 4" I.D. processing quartz tube and vacuum flanges. It is designed for annealing semiconductor wafers or solar cells with diameters up to 3". OTF-1200X-4-RTP is heated by 8 units of 1KW halogen light with a max. the heating rate of 50°C/second. 30 segment precision temperature controller with +/-1°C accuracy is built into the furnace to allow for heating, dwelling, and cooling at various steps. RS485 port and control	

					software are included to make monitoring the temperature profile via PC while simultaneously running furnace possible. This furnace also can be modified into an RTE, CSS or HPCVD furnace	
5	OTF-1200X-IR-IISL	Φ110 (OD) × Φ106 (ID) × 740 (L) mm	- RT ~ 800°C: 50 °C/s - 800 °C ~ 900 °C: 10 °C/s	- 900°C max (< 10 minutes) - 800°C (< 30 minutes) - 600°C (continuous operation)	OTF-1200X-IR-IISL is a dual-zone IR heated rapid thermal processing (RTP) tube furnace with 4" ID quartz tube and two sliding sample holders for easy operation. It is capable of achieving a maximum heating rate of 50 °C/s and a cooling rate of 117 °C/min. The furnace is designed for growing two-dimension and superconducting materials via hybrid physical-chemical vapor deposition (HPCVD), where one heating zone is used as a solid evaporating source and another zone is for vapor deposition. The precision temperature controllers are able to set up programmable heating and cooling profiles with up to 30 temperature segments.	
6	OTF-1200X-50-SL	OD: 2" x ID: 1.81" x Length: 39"	15°C/sec (RT-150°C)	Max: 1200°C (<1 hour) Cont: 1100°C	OTF-1200X-50-SL is a compact automatic sliding tube furnace with 2" OD x 36" L Quartz tube and flanges with 1200°C max. working temperature. The automatic sliding mechanism allows the furnace to slide from one side to the other for achieving the max. heating and cooling rates of > 100°C/min.	
7	OTF-1200X-S-HPCVD	50mm O.D x 44mm I.D x 450mm Length	10°C/sec (150°C - 250°C)	Max: 1200°C Cont: 1100°C	OTF-1200X-S-HPCVD is a compact 2" split tube furnace with internal sample traveling system inside the processing tube. This allows the position & temperature control of the sample stage or crucible via touch screen digital controller. It is designed for multi-functional rapid thermal processing, such as hybrid physical-chemical deposition(HPCVD), rapid thermal evaporation (RTE), and as well Horizontal Bridgman Crystal Growth (HDC) under various atmosphere for new generation crystal research.	
8	OTF-1200X-50-DSL	OD: 2" x ID: 1.8" x Length: 39"	-	Max: 1100°C (< 1 hour) Cont: 1000°C	OTF-1200X-50-DSL is a horizontal sliding 2" tube furnace with variable speed from 1 mm/sec - 100 mm/sec and programmable repeating time. This furnace is designed for directional growth of longer single wall nano carbon tube (SWCT) by CVD method. It can also be used for horizontally growing low melting point metallic single crystal under vacuum and inert gas	

					as <u>Bagdasarov or HDC method</u>). The complete system includes 30 segments precision temperature controller, 2"OD x 36"L Quartz tube and vacuum flanges with 1100°C max. working temperature.	
9	OTF-1200X-80-SL	OD: 80mm x ID: 75mm x 140mm Length	15°C/sec (RT-150°C)	Max: 1200°C (< 1 hour) Cont: 1100°C	OTF-1200X-80-SL is a CE certified & UL Ready slideable tube furnace with 3" IDx55" L Quartz tube and flanges and a maximum working temperature up to 1200°C. One pair of sliding rail is installed on the bottom of the furnace to allow sliding the furnace from one side to another to achieve max. heating and cooling rates up to 100°C/min. For fastest heating, the furnace may be pre-heated to the desired temperature and then be slide to the sample's position. As for fastest cooling, the furnace can be slide to another side after sample heating is completed. Moreover, the heating and cooling rates may reach 15°C/s under vacuum or inert gasses. This furnace provides an alternative for rapid thermal processing at the lowest cost.	
10	OTF-1200X-S-50-DFSL	2" OD x 55" L	Max: 15°C/sec (RT-150°C)	Max: 1200°C (< 1 hour) Cont: 1100°C	OTF-1200X-S-50-DFSL is a dual slidable furnace on the rail. It is a tool for thermal CVD with 2" ODx55"L Quartz tube & flanges and max 1200°C achievable working temperature. Two 2" tube furnaces can be slide on the sliding rail to find positions for source materials thermal evaporation/sublimation and film deposition. Sliding the furnace from one side to another can achieve max. heating and cooling rates up to 100°C/min. Optional motorized sliding, MFC gas delivery and RF Plasma generator are available to build a flexible TCVD system easily at low cost.	
11	OTF-1200X-4-C4-SL-UL	100 mm	-	Max: 1100°C Cont: 1000°C	OTF-1200X-4-C4-SL is a special dual-tube CVD system designed for coating thin film on the metal foil, especially for preparing flexible electrode on metallic foil on new generation energy research. Fast heating and cooling can be achieved by sliding the furnace.	
12	OTF-1320X-4-SL		Max: 10°C/sec	Max: 1320°C (< 1 hr) Max: 1300°C (< 2 hr)	OTF-1320X-4-SL is a 4" quartz tube furnace with SiC heating elements and an electric sliding mechanism for fast heating and cooling. It is capable of achieving a max. heating rate > 50°C/s and a cooling rate > 10°C/s. The furnace is designed for	

				Cont: 1200°C	growing graphene, carbon nanotubes, and 2D materials by CVD.	
13	OTF-1500X-II-50SL	OD 2" x ID 1.75" x Length: 55" (OD: 50.8 x ID 44.45 x Length 1400 mm)	-	Max: 1500°C (<30 min) Cont: 1400°C	OTF-1500X-II-50SL is a 1500°C Two Zone slide-able tube furnace with 50mm OD x 55"L mullite tube and vacuum flanges. One pair of sliding rail is installed on the bottom of the furnace. The furnace can be moved manually from one side to the other for achieving a max. heating or cooling rate up to 60°C/min. For the fastest heating, the furnace may be pre-heated to the desired temperature and then be slid to the sample's position. As for the fastest cooling, the furnace can be slid to another side after sample heating is completed. This system provides a solution for rapid thermal processing at the lowest cost.	
14	OTF-1200X-III-D5-4	Outside tube: 130mm O.D x 122 mm I.D x 1480 mm Inside Tube: 102mm O.D x 94 mm I.D x 1800 mm	Max: 20°C/min	Max: 1200°C Cont: 1100°C	OTF-1200X-5-III-D4 is a dual tube and three-zone tube furnace with max. the working temperature of 1200°C for growing thin films on metallic foil by CVD, specially designed to make graphene and the flexible electrode for solar or battery electrode.	
15	GSL-1100X-III-D11	Outside tube: 130mm O.D x 122 mm I.D x 1480 mm Inside Tube: 102mm O.D x 94 mm I.D x 1800 mm	Max: 10°C/min (RT ~ 800°C) Max: 5°C/min (800~1100°C)	Max: 1200°C (<1 hr) Cont: 1100°C	GSL-1100X-III-D11 is a three-zone dual tube furnace with max. working temperature of 1200°C. Dual-tube design enables large area (~7000 cm ²) CVD film growth on the metallic foil wrapped on the inner tube surface. Tube extractor allows the operator easily remove the inner tube without damaging the film products and be ready for the next step of film transfer. It is an ideal tool for producing graphene sheet or flexible electrodes of energy storage devices.	

16	OTF-1200X-II-PE-RR	80mm OD x 72mm ID x 1400 mm Length 2.83"ID x 55" Length	-	Max: 1200°C (<1 hr) Cont: 1100°C	OTF-1200X-II-PE-RR is a lab-scale Roll to Roll PE-CVD (Plasma Enhanced Chemical Vapor Deposition) tube furnace system, which consists of 300W RF plasma source, 80mm O.D two heating zone split tube furnace at 1200oC Max., 3 channel MFC gas delivery station, and high-quality mechanical vacuum pump, and two vacuum chambers with substrate reeling in and out, as well as touch screen control panel. The R2R system is designed for exploring flexibility to grow graphene or other two-dimension films continuously for the industry.	
17	OTF-1200X-II-HPCVD-SE	60mm O.D. x 54mm I.D. x 1000mm L	Max: 10°C/min	Max: 1200°C (<1 hr) Cont: 100 ~ 1100°C	OTF-1200X-II-HPCVD-SE is a hybrid PVD and CVD (HPCVD) deposition system with six evaporation sources for preparing multilayer 2D materials. The system consists of a dual-zone split tube furnace with the unique Source Feeding System that can drive the crucibles into a processing tube at desired evaporating temperature. The two-zone split tube furnace can achieve fast heating up to 1200°C and create a different thermal gradient by setting the different temperatures for each zone. The source feeding system can push and draw 1 or 2 crucibles with evaporation material through the atmosphere controlled the tube furnace and sequentially evaporate 6 types of materials or co-evaporating of three materials at a time as programed. This is an ideal solution to conduct HPCVD experiments, especially for preparing multi-layer 2D crystal materials. Its built-in PLC touchscreen allows users to manage the feeding method and monitor the temperature of each source. Two 30-segment programmable PID temperature controllers provide excellent control without temperature overshooting.	
18	OTF-1200X-II-ZL	60mm O.D. x 54mm I.D. x 1000mm L	Max: 20°C/min	Max: 1200°C (<1 hr) Cont: 100 ~ 1100°C	OTF-1200X-II-ZL is a hybrid PVD and CVD (HPCVD) deposition system with four evaporation sources for preparing multilayer 2D materials up to 1200oC. The system is consists of a dual-zone split tube furnace with the revolving sample feeding system that can drive the crucible into a processing tube at the desired temperature in the different position of the heating zone. The revolving feed system can push and draw a crucible with evaporation material through the atmosphere controlled tube furnace and sequentially <i>evaporate the material one by one up to</i>	

					four crucibles as the program. Its built-in PLC touchscreen allows users to manage the feeding method and monitor the temperature of each sample. Two 30-segment programmable PID temperature controllers provide excellent control without temperature overshooting.	
19	OTF-1200X-III-HPCVD-S3	One Fused quartz tube:130mm O.D. x 122mm I.D. x 1200mm L) Three fused quartz tubes: 25mm O.D. x 21mm I.D. x 1200mm L	Max: 10°C/min	Max: 1200°C (<1 hr) Cont: 100 ~ 1100°C	OTF-1200X-III-HPCVD-S3 is a hybrid PVD and CVD (HPCVD) deposition system for preparing multilayer 2D materials. The system consists of a three-zone split tube furnace with the unique Source Feeding System that can drive the crucible into a processing tube at desired evaporating temperature. The three-zone split tube furnace can achieve fast heating up to 1200°C and create a different thermal gradient by setting different temperatures for each zone. The source feeding system can push and draw one or three crucibles with evaporation material through the atmosphere controlled 5" D tube furnace and sequentially process up to 3 crucibles (or co-evaporating of 3 at a time) as programmed. This is an ideal solution to conduct HPCVD experiments, especially for preparing multi-layer 2D crystal materials. Its built-in PLC touchscreen allows users to manage the feeding method and monitor the temperature of each source. Three programmable PID temperature controllers provide excellent control without temperature overshooting.	