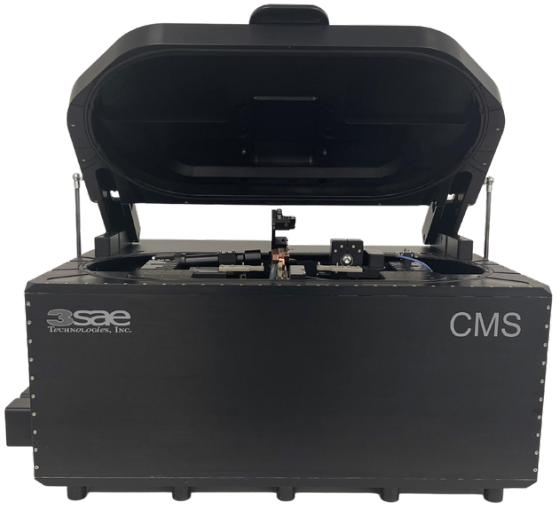
3SAE COMBINER MANUFACUTRING SYSTEM (CMS)



The Combiner Manufacturing System (CMS) is an optical fiber glass processing system designed to maintain production level repeatability for fiber optic combiners and other fused optical components. The CMS includes fiber optic tapering, fiber optic cleaving, fiber optic bundling, and fusion splicing of fiber optics utilizing 3SAE's Thermally Stabilized Ring of Fire® Plasma Technology and achieves the industry's best optical performance, process cycle times, and component cleanliness.

The CMS utilizes 3SAE's patented Ring of Fire® heat source that provides circumferential heating around the fiber or optical component being processed in the CMS. This allows for even heating around the optical fiber as well as very narrow heat source along the axis of the optical fiber. The Ring of Fire® heat source is capable of producing heat widths as small as 300um which is ideal for splicing Photonic Crystal Fibers (PCF) with little or no collapse of the inner air clad structures. The Ring of Fire® arc can also be pulsed to increase mechanical strength of PCF while not allowing the heat to absorb or penetrate the inner structure. The CMS utilizes 3SAE's patented Ring of Fire® technology to create even heating which produces uniformly shaped fiber optic tapers. Additionally, it performs world class end cap splices utilizing circumferential heat uniformity while minimizing mechanical stresses induced by other non-thermally symmetric heat sources.

The CMS can also operate in partial vacuum which is advantageous in producing adiabatic fiber optic tapers. Operating 3SAE's patented "Thermally Stabilized Plasma™" in partial vacuum allows the width of the plasma field to expand up to 10x along the axis of the fiber. Heat sources with a wider heat profile are better for tapering and bundling of optical fibers because the pull distance per unit time is distributed over the molten region in accordance with the profile. Narrow profiles create modulations and stress concentrations that induce optical losses. Our wider plasma field flattens and reduces the frequency of modulations resulting in optical losses of less than 1% in fiber optic tapers.

As the Plasma is thermally stabilized, any other process variation such as electrode wear, will adjust the plasma volume rather than altering its temperature. For this reason, "Thermally Stabilized Plasma™" has 10X thermal repeatability as compared to any preexisting arc technology and is also programmatically adjustable in width and intensity.

An additional benefit of operating in partial vacuum is oxidation of the electrodes is minimized during the fusion splicing and fiber optic tapering processes. This results in virtually debris free fusion splices and fiber optic tapers. High power test data has proven the Ring of Fire® does not contaminate the fiber optic glass surface, eliminating the need for etching and reducing the cost of production and rework.

Table based tapering method allows the flexibility of a syntax based software program to create a custom fiber optic taper program while using a simplified LabVIEW based GUI. Alternately, programs such as "MATLAB" or Microsoft Excel can be utilized to develop custom fusion tapering programs.

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Key Features: Combiner Manufacturing System (CMS)

- Extremely repeatable glass processing heat source ideal for high volume optical component manufacturing with a broad range of operation.
- Unsurpassed heat source provides circumferential thermal uniformity for symmetrical ultra-low loss fiber optic tapering and reduces thermally induced component stress.
- Contamination free heat source capable of producing ultra-high strength multi kilowatt class optical components.
- Fastest cycle times based on standard fusion splice, fiber optic taper, and cleave cycle times averaged together.
- Embedded electrode cooling system for cooling Ring of Fire® and electrical components.
- Automatic alignment of Pitch and Yaw included with <0.01 degree resolution pre-taper alignment, optical fiber to optical fiber alignments, endcap splicing, tapered glass splicing, and fiber optic combiner splicing.
- Exclusive two and three electrode operation modes supported to allow for heat zone dimensional flexibility.
- Exclusive controlled pressure modes provide the best possible application flexibility and repeatability while utilizing “Thermally Stabilized Plasma™”.
- Orthogonal views utilizing 5mp vision system with telecentric lenses providing 4.2mm wide x 3.5mm tall field of view and up to 20 frames per second.
- Live process monitoring via full resolution video imaging of the molten fiber optic glass without under or overexposure.
- In-situ cleaver supports fiber optic diameters from 20um to 500um.
- Capable of fusion splicing and tapering optical fibers ranging in diameter from 125um to 2mm.
- Capable of fusion splicing optical fiber as dissimilar as 125um to 2mm in diameter.
- Scanning software is capable of scanning optical fiber’s diameter before or after a fusion splice or fiber optic taper.
- Automatically captures fusion splice images before, during, and after fusion splice along with splice data and program file for each splice.
- "Hot Imaging” provides live viewing during fusion processing of optical fibers in real time.
- Photonic Crystal Fibers (PCF) can be spliced with little to no air hole collapse.
- Capable of uniformly collapsing Photonic Crystal Fiber (PCF) allowing for positional cleaving, ultrasonic cleaning (no liquid wicking into air holes), and achieving excellent splice losses.
- <50nm X and Y fiber positional resolution of over the full stroke of 12mm.
- Taper lengths of up to 150mm supported in bidirectional mode. *
- Taper lengths of up to 90mm supported in single directional mode.*
- Exclusive "Table Based Tapering™" software included for single direction, bidirectional taper, or custom algorithm program creation and nearly infinite engineer level process control.**

*Taper ratio dependent.

**User can adjust both fiber platform locations, the heat zone location, and the arc power setting 20 times per second for the entire process.

Standard Package

Part Number	Product	Includes
CMS-01-0100	3SAE Combiner Manufacturing System (CMS)	Two orthogonal 5MP cameras with precision double telecentric lenses providing 4.2 x 3.5mm field of view. PC with all necessary software, 23" monitor, user’s manual and accessories. Accessory kit including (2) spare electrode sets, (2) electrode cleaning discs, all necessary PC and CMS interconnect cables. Includes manufacturer's 1-year parts and labor warranty. **Requires one pair CMS fiber holders (sold separately)

Standard Package Capabilities

Capability	Description
Splicing	• Automatic alignment (including pitch/yaw) for fusion splicing 125um up to 2mm diameter. • Supports 2 and 3 electrode fusion splicing. • Atmosphere and thermally stabilized plasma Ring of Fire® technology. • End cap splicing for cylindrical, chamfered, and tapered end caps (additional fixturing may be required).
Tapering	• Automatic taper creation via intuitive software interface or manual table editing. • Tapering methods include Bi-Directional Tapering, Single Direction Tapering, and Table based tapering. • Integrated load cell feedback system for process development and monitoring. • Scanning Function for scanning the O.D. of an optical taper or fusion splice.
Cleaving	• Provides an in-the-box cleaving solution for production of end caps, fiber optic tapers, mode-field adapters (MFAs) and optical fiber optic combiners up to 500µm in diameter. • High quality diamond-tipped ultrasonic blade with piezo-based frequency/amplitude control as well as an semi-automated backstop. • Real time scanning and image feedback capabilities provide reproducible reference and cleave location control. • Cleave location precise to +/- 12.5µm • Improves yields of delicate assemblies by eliminating excess handling needed to transfer to an external cleaver.

CMS Upgrade Packages

Part Number	Product	Description
CMS-01-0150	CMS Work Station Cart	40" 4K display with mount (replaces standard 23" monitor), Ergonomic design with CMS recessed into workstation, Includes PC storage area with locking soft wheels, Lightweight aluminum design
CMS-01-0110	CMS Short End Cap Holding Package	Vacuum based short end cap holding system for supporting short end caps during fusion splicing., 2000um fiber holders (pr), 2 - 1mm I.D.X2mm O.D. capillary tubes.

Technical Specifications

Feature	Specification
Dimensions	71cm (W) x 56cm (D) x 43cm (H)
Weight	~75 kg
Power Source	24VDC 200W (qty 2)
Compressed Air	6.2b (90psi) and 126 L/per min (~4.5cfm)

Accessories and Consumables

Part Number	Product
CMS-01-0300	CMS Fiber Holders – 250um (pr)
CMS-01-0303	CMS Fiber Holders – 400um (pr)
CMS-01-0306	CMS Fiber Holders – 700um (pr)
CMS-01-0309	CMS Fiber Holders – 1000um (pr)
CMS-01-0312	CMS Fiber Holders – 1500um (pr)
CMS-01-0315	CMS Fiber Holders – 2000um (pr)
CMS-01-0320	CMS Fiber Holders – 2500um (pr)
CMS-01-0318	3SAE CMS End Cap Holder (1.1mm-7mm)
CMS-01-0319	3SAE CMS End Cap Holder (5mm-12mm)
CMS-01-0357	CMS Light Injecting PM Fiber Holders (pr) - supports up to 600um coating diameter
CMS-01-0382	Magnetic Copper Electrode Holders (Set of 3) for ROF - CMS/TMS
ACC-01-0147	Power Supply 200W 24V 8.33A 8-pin (CMS/LDS/LFS/LPS/PFS)
ACC-01-0350	Capillary Speed Loader (CSL)
ACC-01-0143	3SAE Automatic Electrode Cleaner (AEC)
CON-10-0023	Diamond Tip Replacement Blade (CMS/LCC/LDS)
CON-10-0026	Electrode (CMS/PFS/TMS) (Requires qty 3)