A Silver Bullet: Impact Mount Technology

Edward Palen, Ph.D., P.E.
PalenSolutions - Optoelectronic Packaging Consulting
and
Michel Rondeau, Ph.D
Valdor Fiber Optics

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A silver bullet is special because of its impact. Impact Mount ferrules not only look like bullets, their attachment to optical fiber is just as fast, and their effect on photonic packaging may be just as pronounced.

Impact Mount Technology (IMT) lowers optoelectronic packaging cost of both active and passive photonic devices. Developed and patented by Valdor Fiber Optics, IMT reduces part count, simplifies module assembly, and enables the designer to utilize precious board real estate more efficiently.

Two immediate applications of IMT are (1) fiber pigtails and (2) add/drop DWDM multiplexers. These are introduced in this article. In both of these applications, IMT lowers device assembly cost in ways that are not currently available by other methods. More importantly, these packaging cost reductions will be demanded in the new market era of photonic components.

Description - How Does It Work?

IMT is a radial compression fit of a ductile metal around a cylindrical glass surface, see Figure 1. The process consists of one quick mechanical step, the impact, between the bare fiber and ferrule using a precision impact mount die. The fiber is stripped of its polymer buffer prior to insertion into the impact mount die.

For single fibers the mechanical fit is hermetic over Telcordia GR-468 environmental exposures. Qualification testing of fibers with impact mounted ferrules maintained helium leak rates of 4x10-11 atm cc/s over 2000 thermal cycles of -40oC to 100oC. This rate is much lower than typical package acceptance leak rates of 1x10-8 atm cc/s. Fiber pull testing on the pigtails exceeded the 1kg requirement and the fiber piston movement was typically less than 80nm.

Many other applications, utilizing the advantages of IMT, are possible. IMT has been used for several years in military applications by Amphenol in their "Harsh Environment Impact Splice" field-installable fiber optic connectors. This successful application of IMT to harsh mil-spec test requirements is a testament to the robustness of the IMT product.

Another configuration called "Fiber Lead Frame," uses IMT to provide a non-hermetic mechanical fit onto several fibers in a bundle. This fit provides sub-micron tolerance control of the fiber cores relative to each other within the bundle. In the seven-fiber bundle, six fibers surround one center fiber in a hexagonal close-packed configuration. This product line of lower cost packaging solutions is called "HeptoPortTM".

Importance to the Industry

1. Fiber Pigtails for Hermetic Seal:

Hermetically sealing optical fiber to the package wall of a photonics device has been a limiting process, both in terms of cost and ability to automate production. Metallization of glass fiber that has been stripped of its protective polymer buffer coating is necessary in order to provide a hermetic seal to the fiber by solder attachment. Metallization of the fiber requires batch processing of fiber pigtails by either thin film metal deposition or by electroless plating. These processes are costly, have limited throughput, and are often subject to processing yield loss.

The need to metallize optical fiber is eliminated by IMT. Attachment of metal ferrules to the fiber is performed in one quick mechanical action, that is naturally compatible with machine process automation.

The metal ferrule accomplishes two things: (1) Hermetic seal of the fiber feed-through to the package wall. (2) Optical coupling attachment of the fiber to optical benches within the package. Attachment of the ferrule may be by laser weld or solder processing. Fiber pigtail configurations supplied for photonic devices using IMT are shown in Figure 2.

The IMT process is one quick efficient mechanical step that is well suited for machine automation. Figure 3 shows a technology demonstration unit for IMT process automation. This type of IMT automation island can be installed within industry standard "pick'n'place" automated equipment to realize low cost, high volume production of fiber pigtails. The fiber pigtail preparation may also be readily integrated with automated alignment and attachment stations when using IMT to attach ferrules onto fiber pigtails.

2. "Fiber Lead Frame" Add/Drop Multiplexers:

The cost of DWDM add/drop multiplexers can be significantly reduced using the IMT "Fiber Lead Frame" configuration, shown in Figure 4. The ability to passively locate multiple single mode fiber cores to sub-micron tolerances using the IMT compression fit on a fiber bundle enables cost advantages. These advantages provide a more competitive option for building add/drop multiplexer modules than the standard use of multiple sets of 3-port thin film filter (TFF) packages, (ref.1). Note that 3-port TFF packages are typically not hermetically sealed for Telcordia applications.

Component count is reduced by using this "Fiber Lead Frame" configuration. For a 1x1 add/drop multiplexer the number of thin film filters and GRIN lenses is halved. Thus, cost of module component bill-of-materials (BOM) is reduced by at least 50%. The reduced degrees of freedom and component alignment variances allow for lower assembly costs. The multiplexer footprint area is halved. This configuration improves channel isolation by -10dB, and allows for bi-directional multiplexer operation.

Summary - Market Need

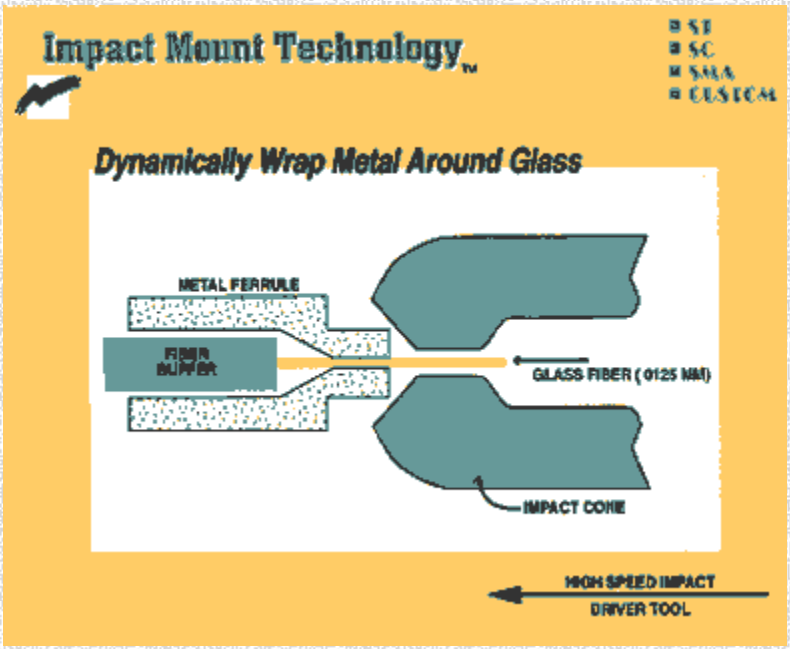
Packaging cost comprises up to 60% of the total cost of manufacturing for optoelectronic modules. It is the main market obstacle for photonic components. Technology applications that reduce the packaging cost and enhance process automation ability, such as IMT, will find broad acceptance in future market recovery.

Reference:

Chun H., Dennis M., and Wei-Zhong, L., "Thin-Film Filters are the Building Blocks of Multiplexing Devices," WDM Solutions, May 2001.

IMT is available from Valdor Fiber Optics, Hayward, California
For information contact Michel Rondeau at michel@valdor.com

Figures are courtesy of Valdor Fiber Optics.



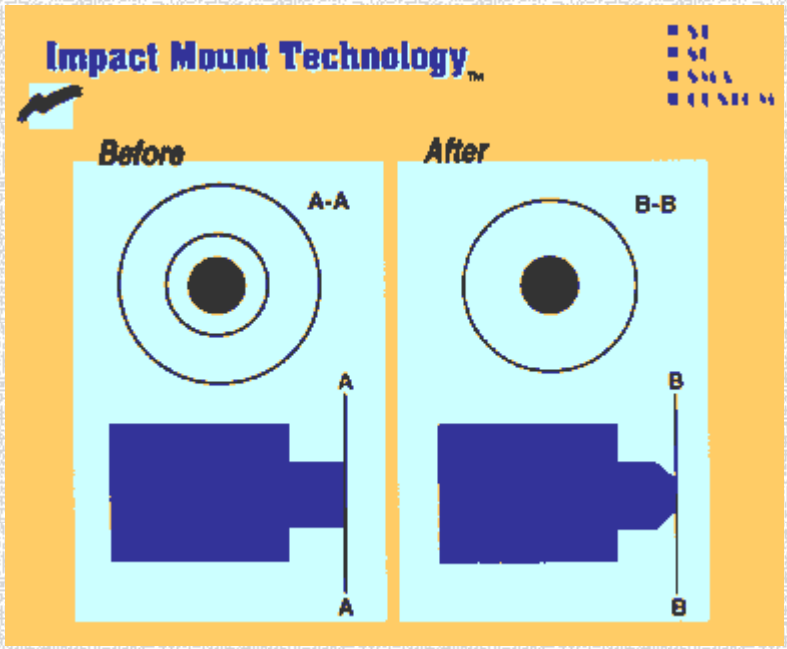


Figure 1: Impact Mount Technology (IMT)
Radial compression fit of metal ferrule onto glass surface of cylindrical optical fiber. Ferrule is sealed hermetically to fiber.

IMT Fiber Pigtail Configurations Used in Photonic Packaging

Figure 2a: Ferrule impact mounted to optical fiber.
2.0 mm Kovar ferrule impacted on 8¡ APC bare fiber with a 0.5 mm protrusion.

Figure 2b: Dual ferrule pigtail assembly:
Front ferrule for optical coupling attachment, Rear ferrule for solder attachment to package wall

Figure 2c: End face polish of optical fiber protruding in-front of IMT ferrule.

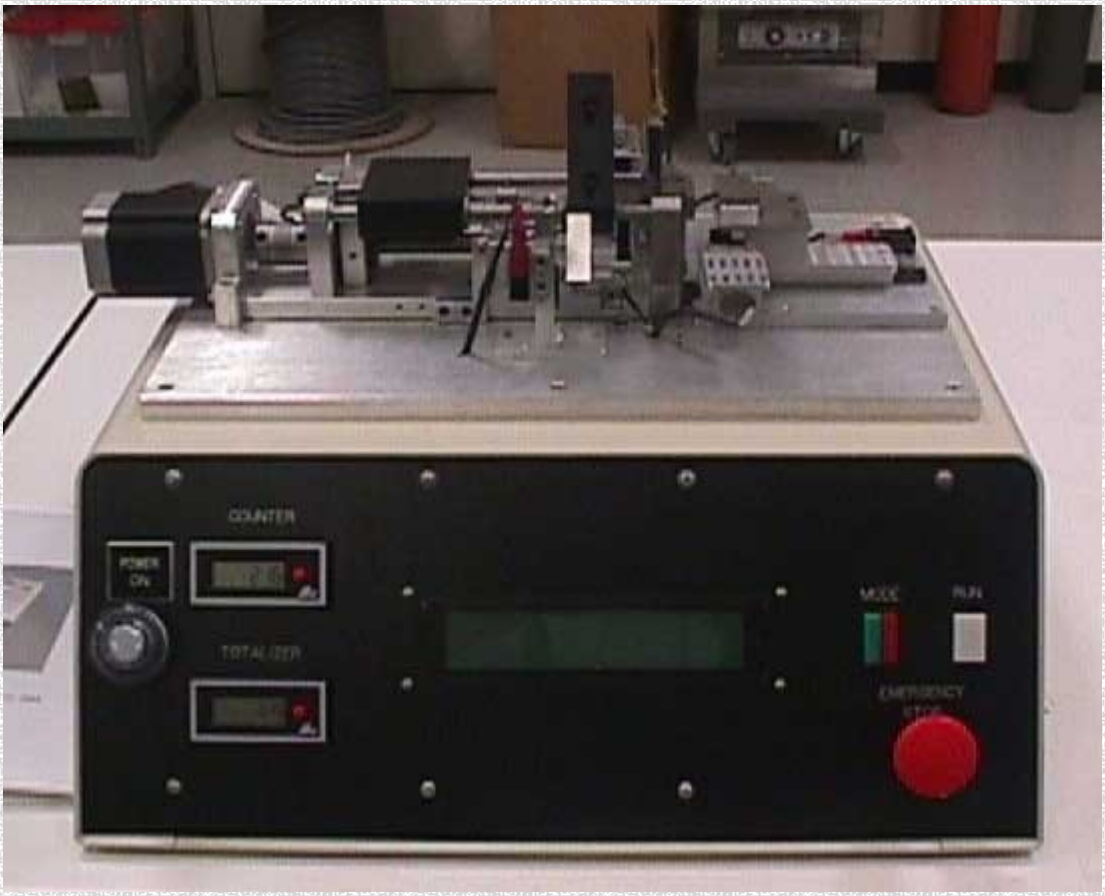


Figure 3: IMT Process Automation Capability Demonstration Unit

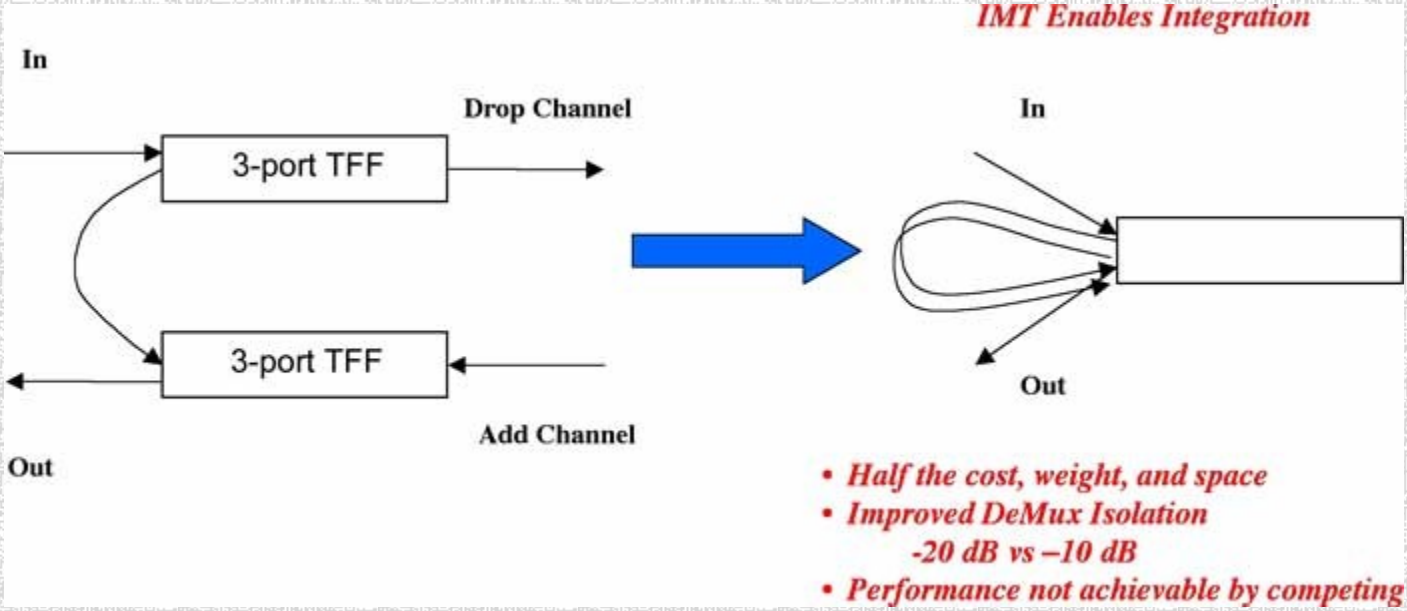


Figure 4: IMT "Fiber Lead Frame" Add/Drop Multiplexer Configuration

Edward Palen, Ph.D.	phone: 415-850-8166	email: epalen@earthlink.net