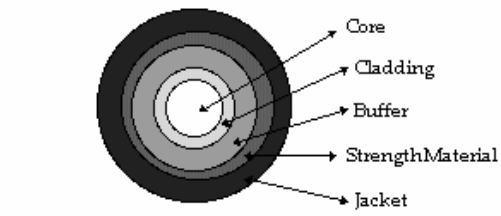
Optical Fiber Cleaning & Care

Fiber Optic Anatomy (Basic)

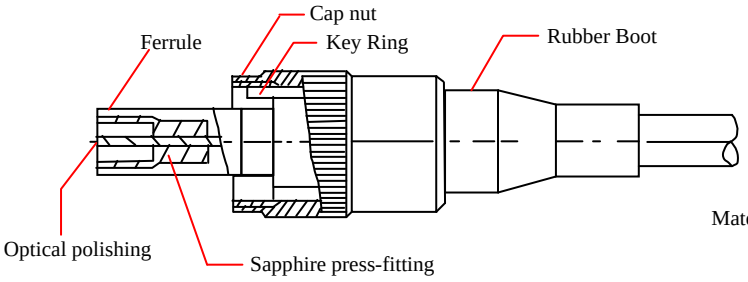
To understand the importance of fiber optic cable and its effects to damage, a basic understanding of the fiber optic anatomy must be understood.

There are generally five elements that make up the construction of a fiber-optic strand, or cable: the optic core, optic cladding, a buffer material, a strength material and the outer jacket (*see figure below*). The optic core is the light-carrying element at the center of the optical fiber and is commonly made from doped silica (typically doped with germania). Surrounding the core is the optic cladding made of pure silica. It is this combination that makes the principle of total internal reflection possible. The difference in materials used in the making of the core and the cladding creates an extremely reflective surface at the point in which they interface. Light pulses entering the fiber core reflect off the core/cladding interface and thus remain within the core as they move down the line.

Cross Sectional View:



Surrounding the cladding is a buffer material used to help shield the core and cladding from damage. A strength material surrounds the buffer, preventing stretch problems when the fiber cable is being pulled. The outer jacket is added to protect against abrasion, solvents, and other contaminants. The above figure represents a typical fiber optic cable. Each end of the cable is terminated with the associated connector hardware:



Materials: Ferrule – copper
Cap nut – brass (Ni plating)
Key Ring – brass (Ni plating)

It should be clear that a fiber optic cable is prone to damage, despite its outer protection. Therefore, a set of fiber handling rules exists to ensure that a cable is handled in such a way, that it maintains its optimum performance.

Fiber Handling

Since the core of fiber optic cable is silica (glass), proper handling procedures need to be observed at all times. Below is a partial list of the most important fiber handling procedures. The intent of these procedures is to maintain optimum performance, minimum insertion loss and most of all, a safe working environment.

General Handling Rules:	
1	Protect the exposed fiber end from coming in contact with all surfaces. *Reason:* Contact with hard surfaces may scratch or chip the end. Touching the exposed fiber with your finger will leave oil residue.
2	The use of high-pressured compressed air should not be used. *Reason:* Propellants may be discharged onto the surface of the fiber end, which may condense moisture or contaminants during use.
3	Clean the connector (plug) end each time it is inserted into an adapter (receptacle). *Reason:* A dirty connector will contaminate an adapter.
4	The minimum bend radius of the fiber must be maintained. *Reason:* A tight bend radius may fracture the glass.
5	If a fiber is fastened using tie wraps, do not over tighten. *Reason:* Over tightening a tie wrap will result in micro-bends, causing excess attenuation.
6	If a fiber needs to be pulled, use the connector strain relief. *Reason:* Pulling on the fiber may result in the glass breaking.
7	Protective covers (end caps, plugs, etc.) should be stored in a clean container. *Reason:* Dirty covers may result in a contaminated fiber end. Clean suspect or contaminated protective covers prior to use or dispose of and replace with new cover.
8	Unused adapters and connectors should always be covered. *Reason:* Covering the adapters and connectors will help to avoid contamination and collection of residue.
9	Use fiber-cleaning materials only once. *Reason:* If optic grade wipes are used to clean the fiber end, they should be discarded immediately after the fiber surface has been wiped to avoid contamination.
10	Never use your hands to clean a fiber work area. *Reason:* If you use your hands to wipe clean a work area, a piece of glass may get lodged into your hands. Due to the size of the glass, this glass may not be visible to the naked eye.
11	Never inspect a fiber optic cable while looking directly into the fiber end while connected to a laser source. *Reason:* Eye damage may occur if you stare directly at an active fiber end. Always insure that the fibers are disconnected from the laser source, prior to inspection.

In summary, proper care and cleaning of fiber and connectors will improve the long-term performance and quality of services delivered by the fibers in a network and minimizes the potential for injury.

Fiber Bend Radius

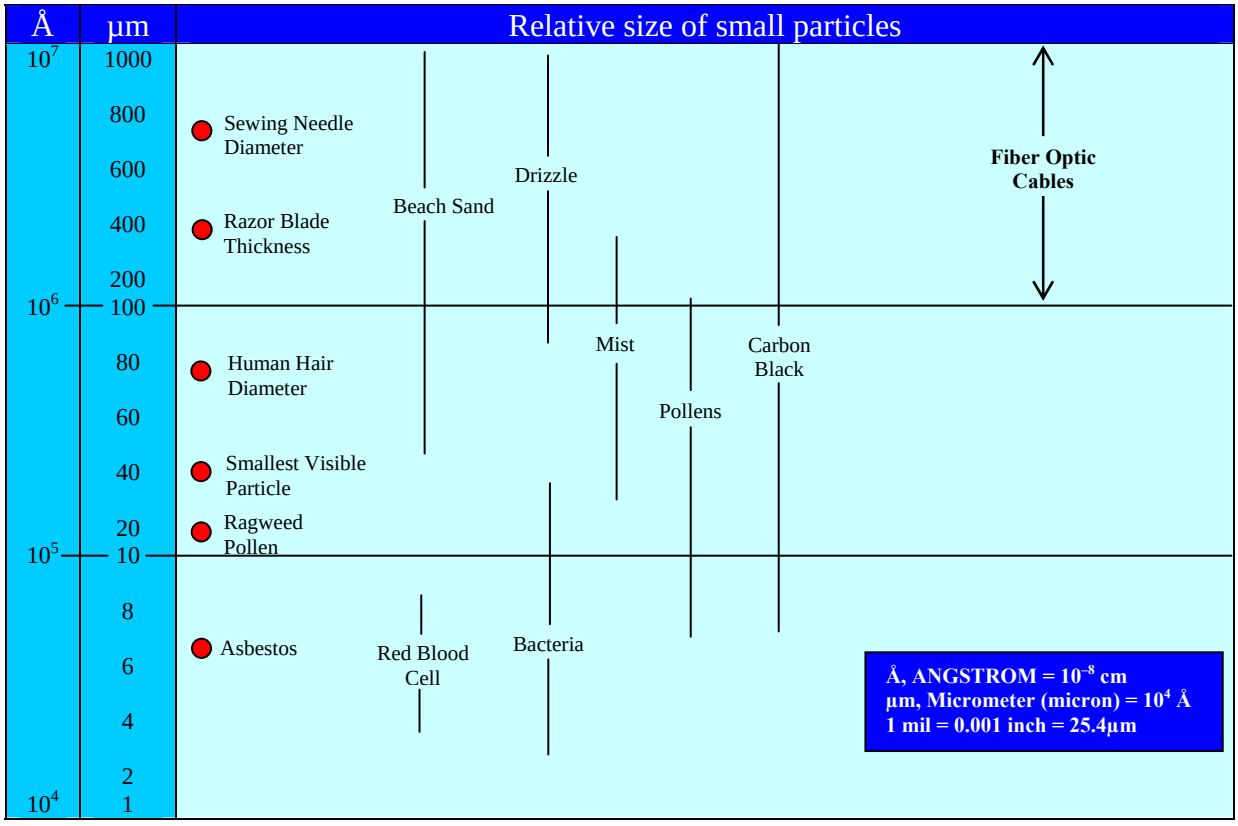
As mentioned in the handling rules above, bending the fiber optic cable beyond the bend radius may cause the glass to fracture inside the fiber optic cable. It is also equally important not to introduce a twist into the cable. This can easily occur if care is not taken during the "uncoiling" of the cable. It is recommended that the fiber be uncoiled as if pulling wire from a spool, where the spool (coil) is free to rotate.

Minimum Bend Radius for Specified Core Diameters

Core Diameter (µm)	Minimum Bend Radius (mm)
100	100
200	100
300	100
400	100
600	150
800	200
1000	250

Particle Size

A "dirty" fiber optic cable is the main cause of poor fiber performance. The smallest of particles on the surface of the fiber end can cause signal degradation. The bigger the particle, the larger the performance drops. To understand the size of the particles we are talking about, please review the chart below:



Available Optical Fibers:

Diameter (µm)	SI[1] Fiber		GI[1] Fiber	
	5M Length	10M Length	5M Length	10M Length
100	4-62167-01	4-62168-01	4-62169-01	4-62170-01
200	4-60106-01	4-60170-01	4-60100-01	4-60122-01
300	4-60255-01	4-60256-01	4-60259-01	4-60260-01
400	4-60099-01	4-60085-01	4-60087-01	4-60088-01
600	4-60001-01	4-60086-01	4-60002-01	4-60089-01
800	4-60093-01	4-60115-01	4-60128-01	4-60131-01
1000	4-60118-01	4-60119-01	4-60133-01	4-60134-01

Note 1: *SI – Stepped Index Optical Fiber*
GI – Graded Index Optical Fiber

The anatomy of the SI (stepped index) and GI (graded index) fibers differ. SI tends to homogenize the beam structure, whereas the GI fiber tends to maintain the mode structure of the laser through the fiber length. The type of fiber used is dependent on the application. Consult the Laser Applications Department at *Miyachi Unitek* for more details.

Fiber Optic cleaning procedure

Equipment required:

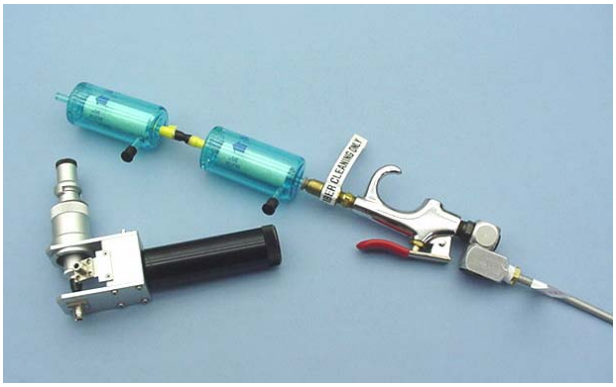
- Fiber Optic end scope (Mitsubishi #EC-002 or equivalent)
- Acetone 9006-01 (J.T. Baker or equivalent)
- “Lint free” lens/optic paper (Edmund Scientific or equivalent)
- “Powder Free” latex gloves or Optics Handling Gloves (protection from Acetone)
- Filtered air

Fiber Optic Cleaning Rules:

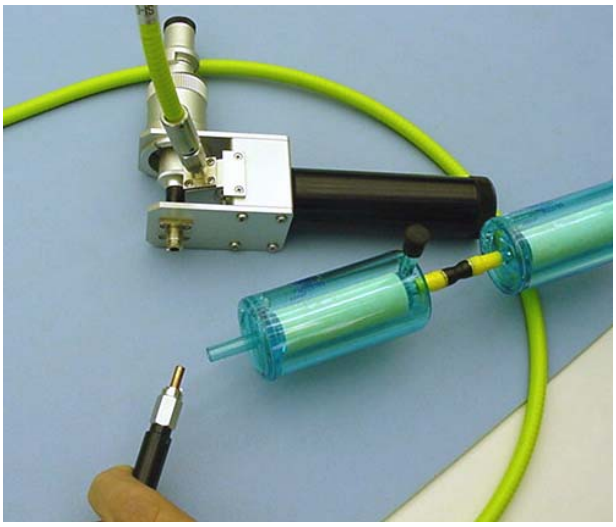
- The person performing the cleaning must be trained.
- The area where the cleaning is to be done must be as clean as possible and away from moving air that may blow contaminates onto the fiber end.
- Never remove the end cap until just prior to inspection or installation.
- Always keep the end of the fiber pointed down to prevent any falling debris from landing on the end of the fiber
- Never touch the end of the fiber or blow on it with your mouth
- When cleaning the fiber end with lint free optic paper, apply only *light* pressure.
- Always assure that the acetone applied to the “lint free” optic paper is not contaminated.

Fiber Optic Cleaning Procedure:

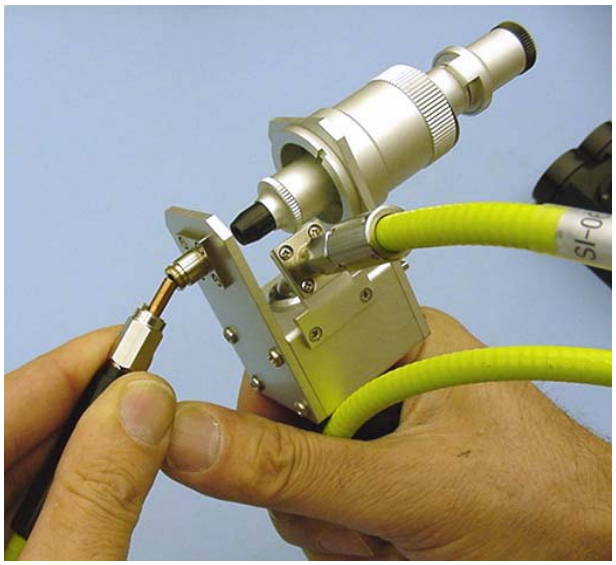
1. Before you start the cleaning process, be sure that you have all of the necessary tools.



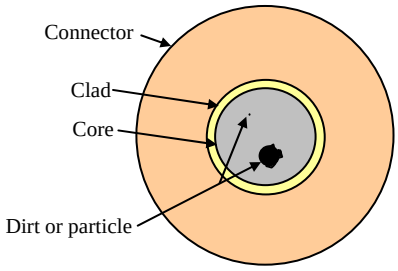
2. Blow air across each end of the fiber optic cable to remove any loose dirt or particulates.



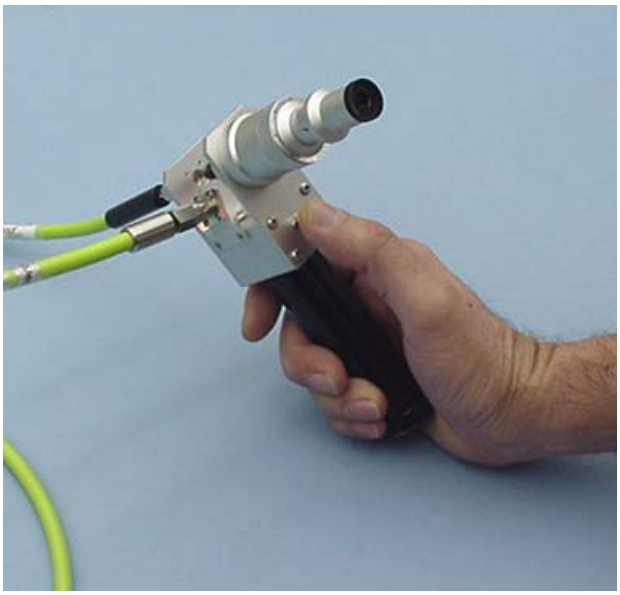
3. Connect each end of the fiber optic cable to the fiber end scope. Take care when inserting the fiber optic cable. Insert the cable at a slight angle to prevent the fiber end from getting scratched on the scope (as shown in the picture). Once the fiber end is inserted, align the key and finger-tighten the cable end.



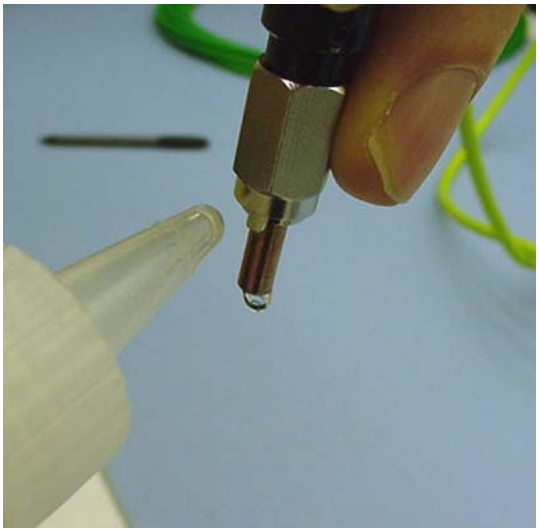
4. Inspect the fiber end for dirt or contamination. The fiber end will look similar to the following:



Note: You can only inspect one end of the cable at a time. If the end you are looking at is free from dirt, you must reverse the cable and inspect the other end.



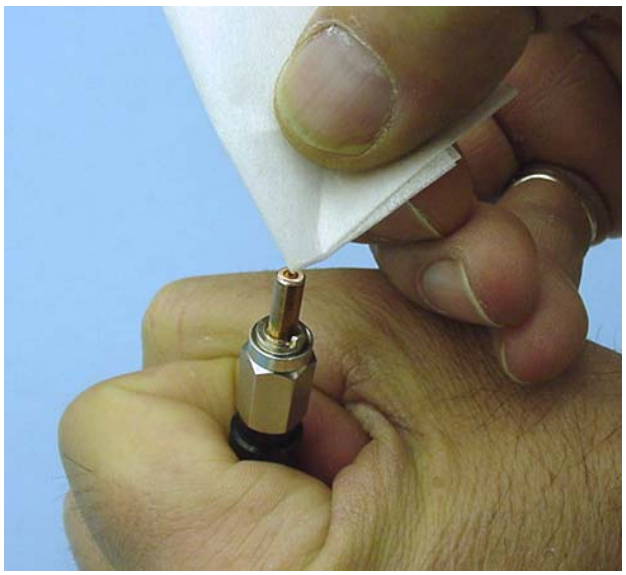
5. If the cable is dirty, then remove the fiber end from the end scope and apply some acetone. To apply the acetone, point the fiber end downward and add a drop of acetone to the side of the connector body. The acetone will naturally collect at the end of the fiber.



6. Blow air across the fiber end to remove the acetone and any loose dirt or particulates. Re-inspect the fiber end. If it is clean continue with the other end of the cable, else continue on with the cleaning steps outlined below.

7. Take a piece of lens cleaning paper and hold it in a horizontal position. Add a drop of acetone to the topside of the lens cleaning paper. Gently rub the fiber end in a circular motion on the bottom side of the lens cleaning paper. Repeat steps 5 and 6 and re-inspect the fiber end with the fiber end scope. If it is clean continue with the other end of the cable, else continue on with the cleaning steps outlined below.

8. If the fiber end is still dirty, then fold a new piece of lens cleaning paper three times to make a rigid "cleaning" corner. Place a drop of acetone on the "cleaning" corner, and gently rub the fiber end. Concentrate the rubbing action to the middle of the fiber (core) and avoid rubbing the connector body. Repeat steps 5 and 6 and re-inspect the fiber end with the fiber end scope. If it is clean continue with the other end of the cable, else repeat this step until the fiber end is clean.



It is important to remember where the particulates are on the fiber end each time you make a cleaning pass. If the particulate appears in the same spot after numerous cleanings, then the fiber may be damaged. When the image in the fiber end scope appears clear and free of particulates, then the fiber end is "clean". Remember to clean the other fiber end.

An important note on particulate size, the smallest particulate the human eye can see is approximately 40µm. If a 50X fiber end scope is used, that means that you will be able to identify a particulate that is approximately 0.8µm in size. If you can see any particulate in the fiber end scope *no matter how tiny*, it is considered dirty.