This Week's Citation Classic™

Miya T, Terunuma Y, Hosaka T & Miyashita T. Ultimate low-loss single-mode fibre at 1·55 μm. *Electron. Lett.* **15**:106-8, 1979.
[Ibaraki Electrical Communication Laboratory, Nippon Telegraph and Telephone Public Corporation, Tokai, Ibaraki, Japan]

A successful realization of a low-loss single-mode fiber with a loss of 0.20 dB/km at 1.55 μm is reported. A discussion about the loss mechanism shows that the loss reaches an ultimate lower-loss limit of silica-based fibers. The paper also indicates the usefulness of the 1.5 μm wavelength region centered at 1.55 μm. [The *Science Citation Index*® indicates that this paper has been cited in over 260 publications, making it one of the most-cited papers ever published in this journal.]

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This paper arose from our discussions on shapes of loss spectra in the 1.4-1.7μm wavelength region. At that time, all of us belonged to the Opto-Electronics Device Section of the Ibaraki Electrical Communication Laboratory (ECL), Nippon Telegraph and Telephone Public Corporation (NTT). We, the fiber fabrication group in NTT, had by that time succeeded in the realization of a low-loss single-mode fiber with a minimum loss of 0.50 dB/km at 1.30 μm and of a multimode fiber with a minimum loss of 0.47 dB/km at 1.20 μm by reducing OH ions from a substrate tube.

So our interests were then focused on the lower loss limit of optical fibers: where does the ultimate loss lie? Fortunately, we found intuitional differences in loss spectra in the 1.4-1.7 μm wavelength region. We then asked, what governs the spectra? We rearranged loss data of fibers into graphs with $1/\lambda^4$ axes. The result indicated that the shape of the spectra is strongly affected by loss due to imperfections in the waveguide. As is described in a later paper,[1] we picked up deposition temperature as one of the most important parameters; it is closely related to the uniformity of deposited glass. It was soon clarified that glass deposition with negligibly small loss due to imperfections needs an appropriate deposition temperature and that the temperature depends on deposition rate or glass material.

One of the practical problems we had to face was the removal of loss factors other than the very small one in fiber preform fabrication. Minute attention was paid to all processes.

At the end of 1978, an optical transmission symposium was held at the Musashino ECL, NTT, where we reported the realization of a 0.20 dB/km single-mode fiber. This marked a milestone in the history of optical fiber fabrication.

I believe most of the citations to the paper refer to the ultimate low loss, because one of the main interests of optical fiber researchers was to determine to what level they could lower fiber loss from theoretical and technical points of view. The work showed a criterion for some of the techniques for low-loss fiber fabrication. That is, we indeed realized the low-loss fiber by the MCVD method and with the composition of GeO_2 doped silica core and pure silica cladding, but most of the discussions for low-loss fiber fabrication were common to other techniques or glass compositions. Another reason for citing our paper is to show the development and usefulness of the low-loss wavelength region in the vicinity of 1.55 μm. Since this report, the term "1.55 μm" has been frequently used as a technical term representing the low-loss wavelength region.

I am pleased with the impact of this paper and the contributions of this work to the development of optical communication systems. We successfully carried out a 134-km-long, repeaterless transmission experiment using low-loss VAD single-mode fibers. Furthermore, our work stimulated development of semiconductor lasers for the long wavelength region of 1.55 μm and also control of the dispersion-free wavelength to the minimum loss region. I would like to commend the other authors for their excellent contributions and cooperation.

1. **Miya T, Kawana A, Terunuma Y & Hosaka T.** Fabrication of single-mode fibers for 1·5 μm wavelength region. *Trans. Inst. Electron. Commun. Eng. Jpn.* **E63**:514-19, 1980.

