INTRODUCTION

In this chapter, different fiber types are presented, and their properties explained. The joint action of these three basic components can lead to fiber-optic systems, mainly applied for data communication. These systems can operate as transmission links with bit rates of 40 Gbit/s and more. But communication systems are also used for recent application areas in the MBit/s region, e.g. in aviation, automobile, and maritime industry. Therefore - besides pure glass fibers - polymer optical fibers (POF) and polymer-cladded silica (PCS) fibers have to be taken into account. More-
over, even different physical layers like optical wireless and visible light communication can be a solution as well as non-optical techniques or microwaves in Radio over Fiber (RoF) systems. Just for completion also non-microwave solutions, ultrasonic techniques are necessary to give the driver information about bodies surrounding the car at small distances.

Since the beginning of the sixties, there has been a light source which yields a completely different behavior compared to the sources we had before: This light source is the LASER. The first realized laser was the bulk-optic ruby laser (Maiman 1960). Only a short time after this very important achievement, diode lasers for usage as optical transmitters had already been developed (see Figure 1) (Quist 1962). Parallel to that accomplishment in the early seventies, researchers and engineers accomplished the first optical glass fiber with sufficient low attenuation to transmit electromagnetic waves in the near infrared region (Kapron 1970).

The photodiode as detector already worked (Adams & Day 1876), and thus, systems using optoelectric (O/E) and electrooptic (E/O) components for transmitters and receivers as well as a fiber in the center of the arrangement could be developed. The main fields of application of such systems are found in the area of fiber-optic transmission and fiber-optic sensors (see Figure 2).

However, the first optical transmission is much older. Native Americans, for instance, already knew communication by smoke signals a long time ago (see Figure 3, Marstaller, personal communication 1990). Furthermore, it was a very sophisticated and modern system because it already was a digital system, consisting of “binary 1” and “binary 0” (smoke/no smoke).

Charles Kao (Kao & Hockham 1966) and Manfred Börner (Börner 1967) can be regarded as the inventors of fiber-optic transmission systems. Nowadays, their invention would not be very spectacular: Take a light source as transmitter, an optical fiber as transmission medium, and a photodiode as detector! Yet, in 1966, it was a revolution because the attenuation of optical glass was in the order of 1000 dB/km, and therefore totally unrealistic for usage in practical systems. Today’s fibers achieve attenuation below 0.2 dB/km, which means that after 100 km, there is still more than 1% of light at the end of the fiber. This low value of attenuation is one of the most attractive advantages of fiber-optic systems compared to conventional electrical ones (see Figure 4). In addition, low weight, small size, insensitivity to electromagnetic interference (EMI), electrical insulation, and low crosstalk must be mentioned. Apart from low attenuation, the enormous achievable bandwidth must be pointed out. That leads to a high transmission capacity in terms of the