Transmission of a fiber coupled saturable absorber (SA) as a function of the chip thickness

In the fiber coupled saturable absorber (SA) the absorber chip is butt coupled between two fiber ferrules. Due to broadening of the optical beam during the propagation through the SA chip in this configuration, there is a mode field mismatch at the second ferrule, where the light has to reenter into the fiber. The broadening of the beam can be described by a simple Gaussian beam propagation. In this case the electric field E is written as *[B.E.A. Saleh, M.C. Teich, "Fundamentals of Photonics", Wiley, 1991, New York]*:

$$E = \frac{w_0}{w_z} \cdot e^{\frac{-(x^2+y^2)}{w_z^2}}$$

with w_0 - beam waist (= mode field radius)

$$w_z = w_0 \cdot \sqrt{1+\left(\frac{z}{z_0}\right)^2},$$

$$z_0 = \frac{w_0^2 \cdot \pi}{\lambda}$$ - Rayleigh range,

λ - wavelength and z - propagation distance.

The mode field overlap of the incoming field E_0 and the field distribution E_F of the fiber mode at the reenter point is given by *[W. Karthe und R. Müller, „Integrierte Optik", Akademische Verlagsgesellschaft Geest & Portig K.-G. (1991)]*:

$$\eta = \frac{\left|\int\limits_{-\infty}^{\infty}\int\limits_{-\infty}^{\infty} E_0(x,y)E_F(x,y)dxdy\right|^2}{\int\limits_{-\infty}^{\infty}\int\limits_{-\infty}^{\infty}|E_0(x,y)|^2 dxdy \cdot \int\limits_{-\infty}^{\infty}\int\limits_{-\infty}^{\infty}|E_F(x,y)|^2 dxdy} = T,$$

which can be assumed to be the transmittance T along the whole device with a nonabsorbing chip.

The following graph shows this transmittance values for different fiber types with respect to the gallium arsenide (GaAs) chip thickness. The mode field diameter (MFD) and the appropriate wavelength are given in the legend.