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多重反射を利用した可変ステップ減衰器

Variable Step Attenuator using Multiple Reflectance

浅井和弘
Kazuhiro Asai
東北工業大学
Tohoku Institute of Technology

Conventional variable attenuators in IR region are far from a practical usage for the coherent detection[1] due to large beam deflection and poor beam quality. Recently, a wadged plate variable attenuator has been introduced and featured as a reliable tool in UV-IR[2-3]. This attenuator consists of four wadged plates. The laser beam is attenuated after transmitting these plates with obeying Fresnel reflection. Therefore, this variable attenuator strongly depends on an optical quality of the wadged plate because of using the transmitting beam . Here we report a new type of variable laser attenuator using a multiple reflection between variable space gapping mirrors.

Fig.1 illustrates the attenuation due to multiple reflection. Let reflectances of mirrors M_1 and M_2 are R_1 and R_2, respectively. If an incident beam is reflected N times on M_1 and M_2, a total reflectance after the multiple reflections is expressed as $(R_1 R_2)^N$, i.e. the output laser power is reduced to $(R_1 R_2)^N I_{in}$, where I_{in} is the incident power. Therefore, the output laser power is controllable due to the number of multiple reflectio N. As a numerical example, if R_1R_2 is 10^{-1}, then it works as a decade attenuator with a variable range of 10-50 dB.

Fig.2 gives a concept of our variable attenuator. The mirror M_1 is set stationarily, while M_2 is moving in a direction normal to the plane of M_1, as shown in Fig.2. When M_2 is shifted from the position of (a) to (b),(c),(d) and (e), for example,the total reflectance (i.e. total attenuation) will be correspondingly varied from $(R_1 R_2)^5$ to $(R_1 R_2)^4$, $(R_1 R_2)^3$,$(R_1 R_2)^2$ and $(R_1 R_2)$.

This variable attenuator has several advantages compared with the wadged plate variable attenuator as follows : 1) Any materials are usable as substrates of two mirrors, i.e. not only tranceparent materials like Ge, ZnSe but also opaque materials like Si, Al_2O_3, SiO_2. 2) The handling of rejected beams are very easy. Any laser beams rejected by M_1 and M_2 are always parallel or normal to the incident beam axis. Two absorbers are schematically shown at each rear of M_1 and M_2 in Fig.2. Furthermore, if the opaque substrates are used, they also work as the absorbers.

Preliminary experimental results using He-Ne laser showed good beam qualities, and small beam deflections. Various design of this variable attenuator will be discussed in UV, visible and IR regions.

1) K.Asai, T.Itabe and T.Igarashi, "Optical and Laser Remote Sensing", D.K.Killinger and A.Mooradian, Eds (Springer, New York 1983)

2) K.Bennett and R.L.Byer, Appl. Opt., 19,2408(1980)

3) K.Bennett and R.L.Byer, Laser Focus, April 55(1983)

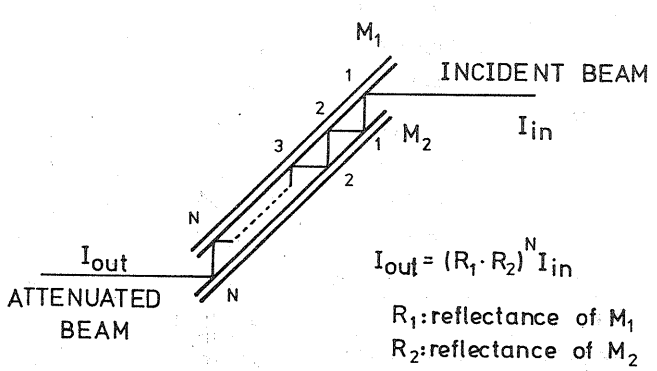

Fig.1 Attenuation due to multiple reflection.

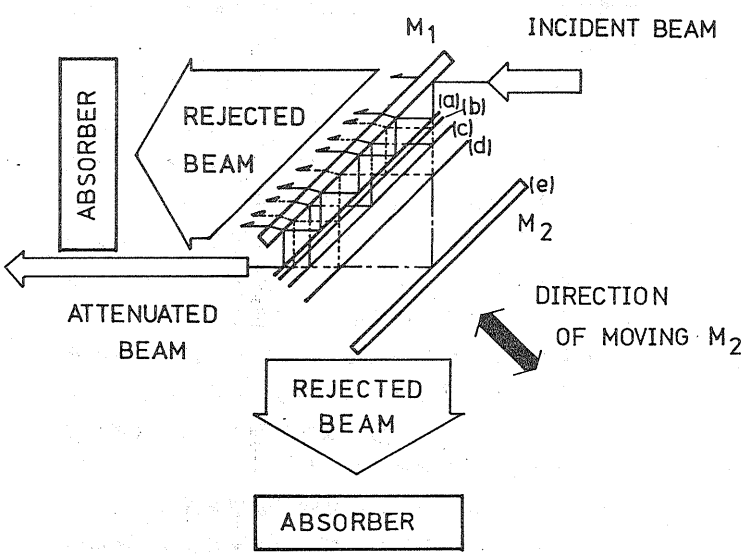

Fig.2 Concept of variable space gapping laser Attenuator.