Reflectionless evanescent-wave amplification by two dielectric planar waveguides: erratum

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In a previous Letter [Tsang and Psaltis, Opt. Lett. **31**, 2741 (2006)], we assert that the total reflection coefficient of two dielectric slabs goes to zero in the limit of single-waveguide resonance. A more careful derivation shows that this is not the case. The correct condition in which reflectionless evanescent-wave amplification can be achieved by two dielectric planar waveguides is derived in this Erratum. © 2006 Optical Society of America

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In a previous Letter,[1] we assert in Eq. (8) that the reflection coefficient of a double-waveguide structure, R, goes to zero in the limit of single-waveguide resonance, Eq. (5) in Ref. 1. A more careful derivation shows that this is not the case:

$$\lim_{r'^2 \exp(2ik_z'a)\to 1} R = \lim_{r'^2 \exp(2ik_z'a)\to 1} \Gamma + \frac{\tau^2\Gamma \exp(2ik_z d)}{1-\Gamma^2 \exp(2ik_z d)}, \tag{1}$$

$$= \lim_{r'^2 \exp(2ik_z'a)\to 1} \Gamma\left(1-\frac{\tau^2}{\Gamma^2}\right), \tag{2}$$

$$=2r-\frac{tt'}{r'}. \tag{3}$$

Although the expression $(1-\tau^2/\Gamma^2)$ in Eq. (2) approaches zero, Γ approaches infinity, and an application of L'Hopital's rule shows that R is given by Eq. (3), not zero. That said, the possibility of a vanishing R, thereby achieving reflectionless evanescent-wave amplification, still exists. This condition is obtained by assuming that R goes to zero but neglecting the case in which $\Gamma=0$,

$$R=\Gamma+\frac{\tau^2\Gamma \exp(2ik_z d)}{1-\Gamma^2 \exp(2ik_z d)}=0, \tag{4}$$

$$\tau^2=\Gamma^2-\exp(-2ik_z d), \tag{5}$$

the total transmission coefficient, T, becomes

$$T=\frac{\tau^2 \exp(ik_z d)}{1-\Gamma^2 \exp(2ik_z d)} \tag{6}$$

$$=-\exp(-ik_z d), \tag{7}$$

which, coincidentally, is the same as Eq. (7) in Ref. 1. Hence, reflectionless evanescent-wave amplification can still be achieved, provided that Eq. (5) in this Erratum, which now depends on d, the distance between the two waveguides, is satisfied.

Using the same example as in Ref. 1, where $\lambda=230$ nm, $d=20$ nm, $n_0=1$, $n_1=2.7$, and $a=20$ nm, Fig. 1 plots $|R|$, $|T|$, and $|r'^2\exp(2ik_z'a)-1|$ versus k_x/k_0. It is clear that R is finite when $r'^2\exp(2ik_z'a)-1$ is zero, but there exists a different k_x at which R vanishes, while $|T|$ at this k_x has the desired value $\exp(-ik_z d)\approx 1.92$ predicted by Eq. (7). The double-peak shape of R and T is due to the nondegenerate waveguide modes of the double-waveguide structure, which would create the undesirable multiple evanescent-wave reflections described in Ref. 1. The numerical example depicted by Fig. 2 in Ref. 1, calculated using a multiple-scattering analysis, is still correct and unaffected by the above issue.

In conclusion, when single-waveguide resonance is reached, the double-waveguide structure is capable of evanescent-wave amplification, but not without reflection. Reflectionless evanescent-wave amplification can still be achieved by two dielectric planar waveguides, provided that Eq. (5) in this Erratum, not Eq. (5) in Ref. 1, is satisfied.

References

1. M. Tsang and D. Psaltis, Opt. Lett. **31**, 2741 (2006).

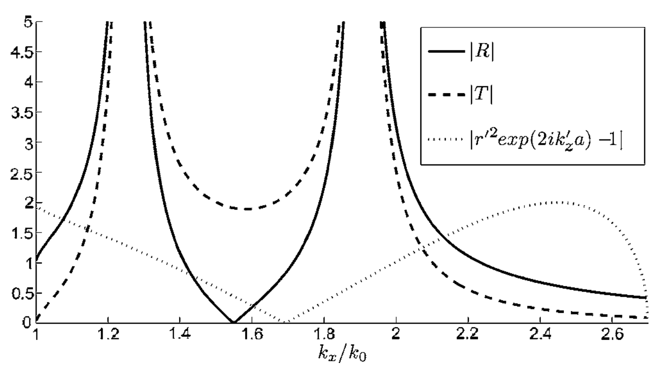

Fig. 1. Plot of $|R|$, $|T|$, and $|r'^2\exp(2ik_z'a)-1|$ versus k_x/k_0.

