interaction with the grating resonance. For the periods of $d = 350$ nm and $d = 400$ nm we observe much larger increase of the reflected powers that cannot be explained by the density of the grating. As we suggest the main reason of this is the plasmon resonance gets power from the grating one. The absorbance for this case for any value of the period behaves almost in the same manner, see Fig. 3 (b).

The electromagnetic properties of the grating made of circular cylinders are similar to the above in the coexistence of two kinds of resonances. The reflectance of sparse gratings Fig. 3 (d),(e),(f) in the visible wavelengths shows a broad plasmon peak pierced by the grating resonances. However for a denser grating where the G-resonance overlaps with the plasmon peak, the latter is enhanced. The transmittance shows the behaviour opposite to the reflectance. The absorbance behaves roughly similar for all values of the period.

III. Conclusion

We have studied two kinds of silver-element gratings suspended in free space with equal area of the element cross-section, one made from circular cylinders and the other from thin strips. Both scattering problems have been analyzed using accurate mathematical approaches. We have discovered that although the geometries of the gratings are different, their electromagnetic properties have similar features. For instance, the G-resonances appear and behave regardless of the structure of the grating elements. It has been shown that in the H-polarization case the effect of the grating resonance on the plasmon resonances can be both positive (reflectance enhancement) and negative (reflectance inhibition). In the E-polarization case, where no P-resonances exist, the effect of periodicity is displayed as suppression of reflectance at the wavelengths of Rayleigh anomalies.

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References

[1] C.M. Linton, “Lattice sums of the Helmholtz equation”, *SIAM Review*, vol. 52, no 4, pp. 630-674, 2010.
[2] V. Twersky, “On scattering of waves by the infinite grating of circular cylinders,” *IRE Trans. Antennas Propagat*., vol. 10, no 6, pp. 737-765, 1962.
[3] D.M. Natarov, V.O. Byelobrov, R. Sauleau, T.M. Benson, and A.I. Nosich, "Periodicity-induced effects in the scattering and absorption of light by infinite and finite gratings of circular silver nanowires," *Optics Express*, vol. 19, no 22, pp. 22176-22190, 2011.
[4] E. Bleszynski, M. Bleszynski, and T. Jaroszewicz, “Surface-integral equations for electromagnetic scattering from impenetrable and penetrable sheets,” *IEEE Antennas Propagat. Magazine*, vol. 36, no.6, pp. 14-25, 1993.
[5] T.L. Zinenko, A.I. Nosich, and Y. Okuno, “Plane wave scattering and absorption by resistive-strip and dielectric-strip gratings,” *IEEE Trans. Antennas Propagat.*, vol. 46, no 10, pp.1498-1505, 1998.
[6] T. L. Zinenko, A. Matsushima, and Y. Okuno, “Scattering and absorption of electromagnetic plane waves by a multilayered resistive strip grating embedded in a dielectric slab,” *Trans. IEICE Electronics*, vol. E82-C, no 12, pp. 2255-2264, 1999.
[7] T.L. Zinenko and A.I. Nosich, "Scattering and absorption of light by nano-thickness negative-dielectric strip gratings," *Proc. Int. Conf. Mathem. Methods in Electromagnetic Theory (MMET*02)*, Kiev, pp. 413-415, 2002.
[8] T.L. Zinenko and A.I. Nosich, "Plane wave scattering and absorption by flat gratings of impedance strips," *IEEE Trans. Antennas and Propagation*, vol. 54, no 7, pp. 2088-2095, 2006.
[9] A.I. Nosich, “Green’s function-dual series approach in wave scattering from combined resonant scatterers,” *in Analytical and Numerical Methods in Electromagnetic Wave Theory*, M. Hashimoto, M. Idemen, and O.A. Tretyakov, Eds. Tokyo, Japan: Science House, ch. 9, pp.419-469, 1993.
[10] P. B. Johnson and R. W. Christy, “Optical constants of the noble metals,” Physical Review B, vol. 6, pp. 4370-4379, 1972.
[11] J. P. Kottman and O. J. F. Martin, “Plasmon resonances of silver nanowires with a nonregular cross-section,” *Phys. Rev. B,* vol. 64, no 23, pp. 235402–10, 2001.