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Title:Potential of glassy carbon and silicon carbide photonic structures as electromagnetic radiation shields for atmospheric re-entry
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Abstract:During high-velocity atmospheric entries, space vehicles can be exposed to strong electromagnetic radiation from ionized gas in the shock layer. Glassy carbon (GC) and silicon carbide (SiC) are candidate thermal protection materials due to their high melting point and also their good thermal and mechanical properties. Based on data from shock tube experiments, a significant fraction of radiation at hypersonic entry conditions is in the frequency range from 215 to 415 THz. We propose and analyze SiC and GC photonic structures to increase the reflection of radiation in that range. For this purpose, we performed numerical optimizations of various structures using an evolutionary strategy. Among the considered structures are layered, porous, woodpile, inverse opal and guided-mode resonance structures. In order to estimate the impact of fabrication inaccuracies, the sensitivity of the reflectivity to structural imperfections is analyzed. We estimate that the reflectivity of GC photonic structures is limited to 38% in the aforementioned range, due to material absorption. However, GC material can be effective for photonic reflection of individual, strong spectral line. SiC on the other hand can be used to design a good reflector for the entire frequency range. © 2012 Optical Society of America.
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