

# Topology optimized carpet cloak by means of a level set based topology optimization

**Garuda Fujii, Masayuki Nakamura**

Department of Environmental Science and Technology, Shinshu University

## Abstract

Carpet cloaks [1] have been received much attention as a new strategy to realize cloaking devices. Topology optimizations [2,3] were applied to several cloaking devices [4,5,6] and are considered to be powerful methods for the design of the carpet cloaks. We present topology optimized carpet cloaks for a PEC scattering object upon a PEC reflector. A topology optimization method based on the level set expression [7] of dielectric structures is used to optimize carpet cloaking structures. Several optimal configurations with various geometrical complexities are demonstrated by adjusting a regularization parameter. A finite element method is used for light scattering analyses, the computation of adjoint fields, and updating level set functions. Level set functions are defined on grid points of grids to express dielectric structures. Dielectric boundaries are interpreted as lines on the iso-surface of the level set functions.

- [1] J. Li, J. B. Pendry, Hiding under the Carpet: A New Strategy for Cloaking, *Phys. Rev. Lett.* 101, 203901, 2008.
- [2] M. P. Bendsøe, N. Kikuchi, Generating optimal topologies in structural design using a homogenization method, *Comput. Methods Appl. Mech. Eng.* 71(2), 197–224, 1988.
- [3] M.P. Bendsoe and O. Sigmund, *Topology Optimization: Theory, Methods and Applications*, Springer-Verlag, Berlin, 2003.
- [4] J. Andkjær and O. Sigmund. Topology optimized low-contrast all-dielectric optical cloak. *Appl. Phys. Lett.*, 98:021112, 2011.
- [5] J. Andkjær, N. A. Mortensen, and O. Sigmund. Towards all-dielectric, polarization-independent optical cloaks. *Appl. Phys. Lett.*, 100:101106, 2012.
- [6] Garuda Fujii, Hayato Watanabe, Takayuki Yamada, Tsuyoshi Ueta, Mamoru Mizuno, Level set based topology optimization for optical cloaks, *Appl. Phys. Lett.* 102, 251106, 2013.
- [7] T. Yamada, K. Izui, S. Nishiwaki, and A. Takezawa. A topology optimization method based on the level set method incorporating a fictitious interface energy. *Comput. Method Appl. Mech. Engrg.* 199, 2876–2891, 2010.