# Using material removal scheme of BESO for hole nucleation in level set based topology optimization of multi-material structures

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## Abstract

A method is proposed to nucleate holes during the level based topology optimization of multi-material structures by using the material removal scheme of the bi-directional evolutionary optimization (BESO). Because the BESO takes discrete design parameterization (0 representing void and 1 representing solid material), when a small amount of inefficient material is removed from the interior of a structure, the effect is essentially the same as that of using the topological derivative to nucleate a hole. As compared with the topological derivative, the BESO is more accessible to engineers because of its conceptual simplicity and easiness of numerical implementation. In other words, the material removal scheme of the BESO is used as a poor man's topological derivative. Such a poor man's topological derivative may not be as theoretically strict as the true topological derivative. Nevertheless, we do not need it to be theoretically strict. All we need is that it can give us a hole. It doesn't matter if the position or size of hole is not so accurate, because the level set will take over and correct it. For removing material, a threshold of sensitivity number is determined. The results of several numerical examples prove that the proposed hole nucleation method is effective and efficient.

**Keywords:** hole nucleation; level set method; BESO; topology optimization; multi-material structures