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Discontinuous Galerkin method for thermal waves diffusion in cracked domains

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SUMMARY

In this work we present a novel Baumann-Oden-type Discontinuous Galerkin (DG) method (cf. [1]) to model the thermal wave scattering in lock-in thermographic inspection of cracked opaque samples of homogeneous materials.

The application of the traditional continuous finite element methods (FEM) require meshing the air located into the gap of the crack, which causes a dramatically increasing of the number of elements in the mesh needed to solve the temperature field. To overcome this problem, we have developed a much more efficient numerical method based on DG elements where thin cracks are considered as an interface characterized by its thermal contact resistance. The numercal method improves the method introduced in (cf. [2]).

In general, DG are natural tools to tackle physical problems with discontinuous solutions where classical FEM fails.The determination details of the bilinear form between continuous FEM and DG are very different. In the last ones different types of stabilization terms are generally required depending on the problem.

This developed method is well adapted to be used in lock-in thermography (cf. [3]) for non-destructive testing of cracks. A 3D heat flow simulation model has been implemented by using a collection of scientific open-source software, NETGEN as mesh generator, FEniCS (cf. [4]) for automated solution of differential equations by FEM and ParaView for data visualization.

Keywords: Discontinuous Galerkin, lock-in thermography, crack detection

AMS Classification: 80M10

References

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