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# Finite Element Analysis of the Influence of Elastic Anisotropy on Stress Intensification at Stress Corrosion Cracking Initiation Sites in fcc alloys

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**Abstract**

A recent finite-element method (FEM)-based study from the present authors quantified the effect of elastic anisotropy of grains on stress intensification at potential intergranular stress corrosion cracking (IGSCC) initiation sites in austenitic stainless steels. In particular, it showed that the auxetic behavior of grains (negative Poisson's ratio) in some directions plays a very important role in IGSCC initiation, since it can induce local stress intensification factors of about 1.6. A similar effect is expected for other *fcc* alloys such as Ni-based alloys.

The present article confirms those results and paves the way to the definition of an IGSCC susceptibility index by identifying grain configurations that are the most favorable for crack initiation. The index will rely on the probability to get those configurations on surface of specimens.

## 1. Introduction

Intergranular Stress Corrosion Cracking (IGSCC) is a recurring issue in Light Water Reactors (LWR). Since the early 1960s (e.g., [1]), IGSCC was successively reported on: sensitized 304 and 316 austenitic stainless steels in Boiling Water Reactors (BWR), nickel-based alloys (alloys 600 then X750) in primary or secondary water of Pressurized Water Reactors (PWR), irradiated stainless steels as well as cold-worked non-sensitized stainless steels in PWR and BWR. Such degradation entailed large maintenance costs, e.g., to replace steam generators, reactor vessel heads, or baffle plate bolts in PWR. Outcomes of large research programs run in many countries (e.g., [2,3,4,5,6,7,8,9,10,11,12,13]) helped to select materials and operational conditions that limit IGSCC degradation in LWR. However, it must be admitted that a full understanding of the mechanisms controlling this type of degradation has not been established yet, and it is still difficult to prevent in-service cracking. Further work is needed.