Sensitivity analysis on the Performance of THz nanocarbon-based passive devices

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1. Summary

A FEM model of THz passive component will be presented and used to assess the effect on the whole device performance of the uncertainties affecting geometrical and physical parameters of the device by means of sensitivity analysis. Moreover, with the aim of support the experimental validation, the overbounding and underbounding of the performance will be derived ranging the actual behaviour of the designed component.

2. Description of the problem and proposed approaches

The performance *f* of an electromagnetic system is the output that the designer looks for: several efforts have to be applied in order to ensure the satisfaction of the customer constraints. Usually, the designed parameters are considered fixed and well know, i.e. the vector $\underline{x}_0 = (x_{10}, x_{20}, \ldots, x_{n0})$ of the n design parameters, and it corresponds to a point in the parameter space $D = [x_{1L}, x_{1U}] \times \cdots \times [x_{nL}, x_{nU}]$ with x_{iL} and x_{iU} the min and max values of x_i parameter respectively. Nevertheless, there are actually several sources of uncertainty leading to unavoidable Δ_i variation in the parameters. It means that each component of the design parameter vector becomes "interval value", given by $x_{i0} \pm \Delta_i$, and the point $\underline{x}_0$ becomes the hyper-rectangle $U(\underline{x}_0) = [x_{10} - \Delta_1, x_{10} + \Delta_1] \times \ldots \times [x_{n0} - \Delta_n, x_{n0} + \Delta_n]$ (fig. 1 for n=3) [1]. As a consequence, also the performance will be an "interval function" that could be mismatched with respect to the desired design. This is especially true when the technology is not well established or the material behaviour and its physics is still understudies such as the case of nanocarbon-based device [2]. In this case, bounding of the performance function and sensitivity analysis can help to identify the more effective parameter and the results of such analysis can be used as a support in the experimental validation [3]. To this aim, A FEM model of THz passive component will be presented [4] and used to assess the effect on the whole device performance of the uncertainties affecting geometrical and physical parameters of the device [5]. In particular, a Monte Carlo procedure, supported by Vertex Analysis, will be applied on a numerically solved model of the device, developed with a commercial software (Comsol Multiphysics). From the simulated data an underestimation of the overbounding, $f_M(\underline{x}) = \max_{\underline{x}_0 \in D}\left(\max_{\underline{x} \in U(\underline{x}_0)} f(\underline{x})\right)$ and an overestimation of the underbounding, $f_m(\underline{x}) = \min_{\underline{x}_0 \in D}\left(\min_{\underline{x} \in U(\underline{x}_0)} f(\underline{x})\right)$ of the performance will be derived from the N Monte Carlo trials, ranging the actual behaviour of the designed component by considering uncorrelated and uniformly distributed uncertain design parameters in the space parameters D. Moreover, simulated scattered data will be used to evaluate the sensitivity of the performance due to the assumed variability in discrete way [6].

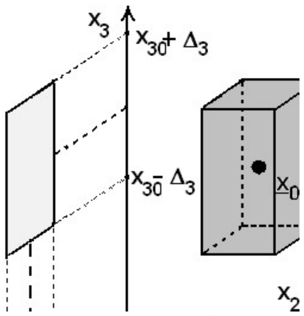

Figure 1 Hyper-rectangle $U(\underline{x}_0)$ representing all the possible values assumed by the vector $\underline{x}$ when each component is affected by a variation Δi

3. Acknowledgement.

The work was carried out within the framework of the H2020 project 823728 DiSeTCom and of H2020-SGA-FET- Graphene Flagship- Graphene Core 3, GA881603

4. References

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