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VO_2 thin films as electromagnetic shields with dynamic effectiveness

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Sensitive electronics must be protected from electromagnetic interferences such as those associated with high intensity radiated field (HIRF). This is currently achieved by plain electronic boards in a metallic enclosure that behaves as a Faraday cage. Indeed, most metals provide suitable levels of shielding effectiveness (*SE*) at microwaves because of their high electrical conductivity. Nevertheless, depending on the electromagnetic environment, a high level of *SE* is not always required, and can even be detrimental to the normal operation of some electronics. Moreover, in the absence of any surrounding HIRF sources, it is advantageous to keep the *SE* level as low as possible to prevent any electromagnetic self-perturbation of electronics that can arise in a high Q-factor metallic enclosure.

VO_2 is a good candidate to produce shields whose *SE* can dynamically be tuned as such material exhibits an insulator to metal transition (IMT) above 65°C [1]. The present study aims at controlling the *SE* level of a VO_2-based device through a heating/cooling process acting directly on the material electrical conductivity. A 725 nm-thick VO_2 film was deposited by RF magnetron sputtering on a 50 mm × 50 mm C-cut sapphire substrate, and then *in-situ* post-oxidized to get the required stoichiometry as shown by XRD analyses. The IMT thin film was also characterized using the standard four-point probe technique. It displayed a resistivity variation from 1.243 Ω.m at room temperature (25°C) to 3.078×10^{-5} Ω.m at 75°C. The *SE* of the sample was then measured using the nested reverberation chamber procedure (Fig. 1(a)), as detailed in [2]. The VO_2 shield exhibits a *SE* variation of more than 8 dB over the 2-34 GHz frequency range between the insulating and conducting states (Fig. 1(b)). To our knowledge, this sample constitutes the first example ever of an EM shield whose *SE* level can dynamically and reversibly be controlled. An analytical model previously developed was used to compare numerical simulations with *SE* measurements [3]. It predicts the trend of the shield behavior with a satisfying accuracy from the *a priori* knowledge of the reported resistivity in the conducting state.

[1] M. Taha *et al.*, Sci. Rep., 7, 17899 (2017)
[2] C. L. Holloway *et al.*, IEEE Trans. Electromagn. Compat., 45, 350 (2003)
[3] Y. Corredores *et al.*, IEEE Trans. Electromagn. Compat., 59, 1070 (2017)

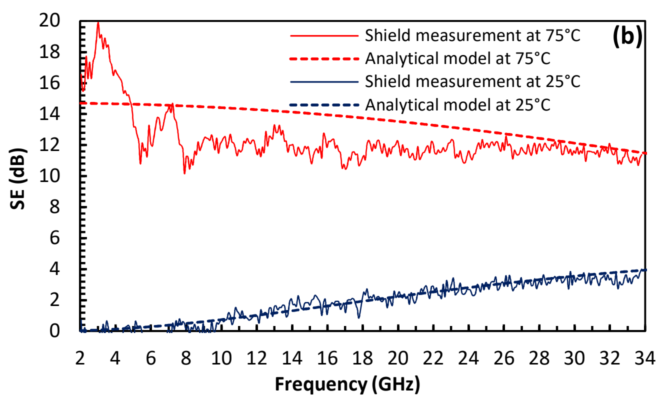

Figure 1: Picture of the Shielding Effectiveness measurement setup (a); Shielding Effectiveness measurements of the VO_2 sample vs. frequency at 25°C and 75°C against numerical simulations (b)