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Preliminary Results on the beam scanning capability of Smart Eelctromagnetic Skins

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The foreseen characteristics of the next-generation communication systems make it necessary to define new paradigms for the network. While the use of mm-waves or sub-THz frequencies seems to be very promising due to the extremely high bandwidth that their use can guarantee, they suffer from higher losses, that are responsible for the degradation of the coverage. To address this issue while maintaining network simplicity, cost-effectiveness, and low power consumption, it becomes fundamental to consider the propagation environment as an additional design parameter. This is possible thanks to the introduction of Smart Electromagnetic Skins (SESs), i.e., very thin surfaces able to provide a not specular reflection to reach blind spots or cover desired areas. In the case in which they can also provide some reconfigurability, they are usually named Reconfigurable Intelligent Surfaces (RISs). Even if RIS are generally not considered active devices, since they do not include amplifiers, they need a control network to vary the phase provided by each of the unit cells in which the surface is discretized. Given that their number is typically in the order of thousands, the control network required to manage RISs is quite sophisticated.

To avoid this drawback, here a different solution to achieve some scanning capability of a reflecting surface is investigated. The exploited idea is that designing a SES, able to change the provided pointing direction when its position with respect to the direction of arrival of the incident field is changed. This allows the use of an SES that is passive in the most restrictive sense, and then to control mechanically its position. While this solution seems particularly suitable when a curved SES [1], mounted on a street/light pole, is used, since it could be simply rotated around the pole, at this initial step a planar surface is considered. It is discretized with 50×74 unit cells, with size 3.6 mm = 0.327λ at the design frequency of 27.25 GHz. The unit cell, shown in the blow-up of Fig.1a, consists of a layer of Diclad527 (ε_r = 2.55, tanδ= 0.0022) with thickness h = 0.508 mm, metallized on both sides. The metallization on the top presents a slot with the shape of a cross, with varying size W. Above this, there is a further layer, with a thickness of 1 mm, made of Lexan (ε_r = 2.8, tanδ= 0.01). The SES is designed to provide a phase distribution obtained as a linear combination of those required to have two different pointing directions, each associated with a different direction of arrival of the incident field. To check the feasibility of this approach, the reflecting surface in Fig. 1 is designed: the pointing directions are assumed to be characterized by φ_{max} = 90°, θ_{max} = 15° and θ_{max} = 40° (see the reference system in Fig. 1a) while the incident plane waves impinge with angles φ_{inc} = -90°,θ_{inc} = -10° and θ_{inc} = -30°, respectively. Then, the position of the SES is changed, to vary the direction of arrival of the field, and the RCS plotted in Fig.1b for different positions is obtained. A scanning larger than 20° achieved in the yz plane with a reduction of the maximum RCS no larger than 1.3 dB and no significant increase of the SLL confirm the feasibility of the proposed solution to realize a reconfigurable intelligent surface. At conference time results for a curved SES will be also presented.

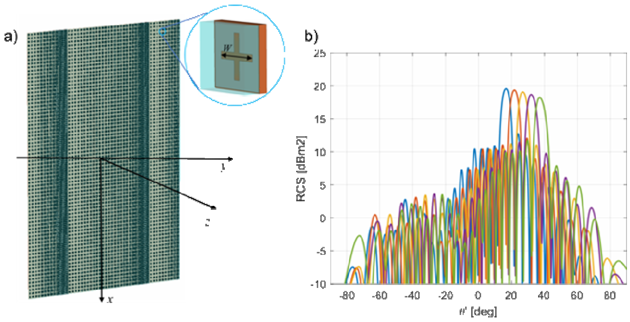

Figure 1. a) designed SES and unit cell in the blow-up. B) RCS in the yz plane for different position of the SES.

1. A. Freni, M. Beccaria, A. Mazzinghi, A. Massaccesi, P. Pirinoli, “Low-Profile and Low-Visual Impact Smart Electromagnetic Curved Passive Skins for Enhancing Connectivity in Urban Scenarios,” Electronics, 2023.