

Similarity of Properties of Metamaterial Slow-Wave Structures and Metallic Periodic Structures

Sabahattin C. Yurt, *Student Member, IEEE*, Ahmed Elfrgani, *Student Member, IEEE*,
Mikhail I. Fuks, *Senior Member, IEEE*, Kostyantyn Ilyenko, *Senior Member, IEEE*,
and Edl Schamiloglu, *Fellow, IEEE*

Monsieur Jourdain: "For more than 40 years I've been speaking prose without knowing it." (Molière, Le Bourgeois Gentilhomme).

Abstract—A study of the evolution of wave dispersion in systems of all-metallic periodic structures with increasing corrugation depth shows a similarity of the properties of waves in metamaterial slow-wave structures (MSWSs) and traditional metallic SWSs used in high-power microwave sources. We show that the main properties of MSWSs, such as the existence of a lowest order negative dispersion wave below cutoff, also appear in ordinary metallic periodic systems with deep corrugations. Furthermore, we find that the appearance of negative dispersion in all-metallic periodic structures with increasing corrugation depth is accompanied by a hybrid mode being identified as the lowest order negative dispersion mode.

Index Terms—Dispersion diagram, group and phase velocities, high-power microwave (HPM), hybrid modes, metamaterials, negative dispersion, slow-wave structure (SWS).