Itinerant conductance in fuse-antifuse networks

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Fluid flow through a porous medium is frequently described in terms of a complex network system of steady-state flow channels, which are more or less tortuous depending on the strength of the disorder. Preferential channeling in these systems is a result of minimizing the dissipated energy or flow resistance and is thus typically unique. When the fluid erodes and deposits material, however, the clogging and reopening of channels depends on the evolution of local flow [1]. In a recent work [2], we proposed an electrical analog network model that, under certain conditions, a new itinerant state can be attained in which these preferential channels constantly change their locations. This occurs when the elementary units of the network are fuse-antifuse devices, namely, become insulators within a certain finite interval of local applied voltages. As a consequence, the macroscopic current exhibits temporal fluctuations which increase with system size. We determine the conditions under which this exotic situation appears by establishing a phase diagram as a function of the applied field and the size of the insulating window. Besides its obvious application as a versatile electronic device, due to its rich variety of behaviors, this network model provides a possible description for particle-laden flow through porous media leading to dynamical clogging and reopening of the local channels in the pore space.

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