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Partially synchronized states in small networks of electrochemical oscillators: effect of heterogeneities and network topology[1]

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When electrochemical reactions take place on electrode arrays, a network can form through the potential drop among the elements. Such networks can generate spatially organized partially synchronized states using oscillatory chemical reactions with two fundamental mechanisms. In oscillations with nearly identical natural frequencies, we describe the emergence of chimera states. The experiments point out the importance of low level of heterogeneities (e.g., surface conditions) and optimal level of coupling strength and time-scale as necessary components for the realization of the chimera state. For experimental conditions where chimera states are not possible, we analyze the spatially organized partially synchronized states as a function of underlying heterogeneities and network topologies. As a prototype system, we consider three oscillators with superimposed local and global coupling topologies. An analytical formula is derived for the mixed local/global coupling topology for the critical coupling strength at which full synchrony is achieved. The formula is verified with experiments using electrochemical oscillator networks.

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