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Zero resistance materials and technologies

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Electrical power consumption occurs because of the resistance to the flow of electrical current. The power lines and transformers as well as information and computation consume more than 20% of the world's electricity. In this presentation, we will discuss the latest development on superconductors and emerging materials in which electrical current can flow without resistance for ultra-low energy consumption technology. A number of emerging electronic materials such as topological insulators, parabolic or Dirac type spin gapless semiconductors (SGSs), Weyl metals with exotic band structures, Dirac type systems or topological Dirac system, and excitonic insulators will be discussed. How to achieve zero resistance transport in spin gapless semiconductor and topological insulators will be presented. Realization of emerging quantum effect such as quantum Hall, Quantum anomalous Hall, quantum spin or quantum anomalous spin Hall effects will be discussed. A few emerging technologies which can drive 2D systems into zero resistance state will be discussed. Furthermore, the ultimate questions in material and property's design are raised: 1) How many new electronic materials or new electronic properties are still there? 2) What are they? 3) How to create them? I will present a number of new strategies we have developed for the design of new class of materials and properties. We will discuss how new electronic materials can be designed by shaping electronic band structures. To answer the three questions, a very simple model, the codes of matter/materials, based on the three ubiquitous and paramount attributes of all existing matter/materials, charge (Q), spin (S), and moment (K) is introduced. We will introduce a new periodic table which consists of all codes responsible for physical properties. The principles of the codes and their applications in design of new materials and properties will be presented. Many new types of exotic physical states and their possible experimental realizations will be discussed.

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