Silicon continues to surprise with potentially powerful new properties and applications

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Abstract

In recent years, it has been shown that silicon is not only the foremost electronic and photovoltaic material but can be structurally modified to dramatically enhance its properties and applications. This presentation highlights two such cases. First, silicon has been shown to possess up to 12 crystalline phases in addition to the equilibrium diamond cubic structure that has fueled the silicon chip revolution. These phases can be accessed by applying pressure, by using a diamond anvil cell, by indentation pressure, or even by femtosecond laser irradiation. Many of these phases are metastable at room pressure and temperature, and some have been shown to have interesting narrow bandgap semiconducting, as well as superconducting properties. Although such properties have not yet been exploited commercially, mainly as a result of scale-up limitations, they show considerable promise for novel applications. The second part of this presentation addresses a further area of novel silicon research, namely hyper-doping of silicon with transition metals to form dilute silicon alloys, that has been demonstrated to have important applications for near-infrared photodetectors. One such case, gold-hyperdoped silicon, possesses an intermediate band within the silicon bandgap that can be exploited for intriguing optoelectronic applications.