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Exotic Forms of Silicon for Energy Applications[1]

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Over the last few decades many exotic forms of carbon, such as carbon-60, carbon nanotubes, and graphene, have generated novel scientific discoveries and revolutionized many important applications. Similar potentially transformative breakthroughs may be expected with exotic forms of silicon. Such structures include, but are not necessarily limited to, (1) those formed under high pressure that are metastable at ambient pressure, (2) single layers of Si (silicene), (2) clathrate Si, which has been studied for superconducting and thermoelectric properties but not in any detail for semiconductor applications, (3) nanostructured forms of Si (nanodots and nanowires), including those composed of diamond Si, (4) porous Si, and (5) any other structures that differ in their structural, optical or electronic properties from bulk diamond Si. Silicon is an abundant, non-toxic element around which an advanced technology exists for semiconducting devices based on diamond Si. One of these exotic forms of Si could form the basis for the next revolution in electronics or even opto-electronics, since some forms exhibit direct, or nearly direct, band gaps. Recent results toward producing pure and dopable semiconductors out of Si nanodots imbedded in amorphous matrices and in clathrate Si and clathrate Si-Ge alloys will be discussed.

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