Filling the gap

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Graphene has been getting a lot of press [1] lately touting it as the electronics material of the future. It is a strong single-layer material with high electron mobility [2]. All good things for a semiconductor material.

But single-layer graphene lacks something very important for a semiconductor material: a band gap. By going to multilayers, [3] a band gap can be created. This is very promising news. But there is even more promising news. [4]

Molybdenum disulfide [4] (MoS2) inherently has a band gap and can be used to make semiconductors. It all depends on the "flatland" concept. Two dimensional materials. Well, two and a half dimensions actually, as they cover area but are only a few atoms thick.

> The latest “new” material, molybdenum disulfide (MoS2) — which has actually been used for decades, but not in its 2-D form — was first described just a year ago by researchers in Switzerland. But in that year, researchers at MIT — who struggled for several years to build electronic circuits out of graphene with very limited results (except for radio-frequency applications) — have already succeeded in making a variety of electronic components from MoS2. They say the material could help usher in radically new products, from whole walls that glow to clothing with embedded electronics to glasses with built-in display screens.

MIT is doing some serious work [5] on the material. They report that because of its high band gap (1.8 volts compared to silicon's 1.1 volt [6]), the off-state of a transistor made with MoS2 will have much less leakage than one made with silicon.

No material is perfect, however; electron mobility [7] in molybdenum disulfide is not very high. On the order of 500 cm^2/Vs compared to around 1500 cm^2/Vs for silicon and 200,000 cm^2/Vs for graphene. These MoS2 transistors will not be at the forefront of high-frequency devices.

The meaning of all this is straightforward. As time goes on, we will see semiconductors better-tailored for each individual application. We already are seeing that now with various semiconductors for LEDs. Silicon carbide for power applications and even germanium (in conjunction with silicon) is making a comeback. With these new materials, the range of what is economically possible will get wider.

M. Simon's e-mail can be found on the sidebar at Space-Time Productions [8].

Engineering is the art of making what you want from what you can get at a profit.

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