2D materials

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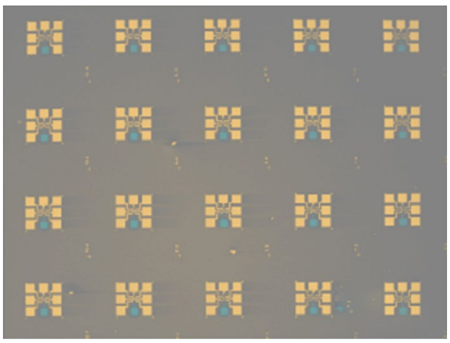
Indium selenide wafers for 2D electronics



Indium selenide (InSe) is a two-dimensional (2D) semiconductor that could potentially replace silicon as the channel material in sub-3-nm technology nodes. However, although it has a theoretically high mobility of around 1,000 $cm^2 V^{-1} s^{-1}$, InSe grown by chemical vapour deposition or molecular beam epitaxy at the wafer scale exhibits worse performance than other 2D semiconductors such as molybdenum disulfide. One reason for this is that the vapour pressure of selenium is many times higher than that of indium at the same conditions, so maintaining a constant stochiometric ratio between the two elements (and thus growing the same InSe phase) is challenging. Kaihui Liu and colleagues now report a solid–liquid–solid growth method to create high-crystallinity, pure-phase InSe films across a 5 cm wafer.

The researchers — who are based at Peking University, Renmin University of China, Soochow University, and Suzhou Laboratory — first deposited an amorphous InSe film on a sapphire wafer by magnetron sputtering. The wafer is then placed in a steel basin, covered with a fused silica 'lid' and sealed at the edges with liquid indium. Finally, the assembly is heated to cause the amorphous InSe to recrystallize. An indium-rich liquid interface is formed that lowers the formation energy of crystalline InSe compared with amorphous InSe and, because the set-up is sealed, the ratio of indium to selenium is maintained.
2D field-effect transistor arrays made with the crystalline InSe, as well as a 2.6-nm-thick HfO_2 dielectric, exhibit average mobilities of 287 $cm^2 V^{-1} s^{-1}$ and subthreshold swings of 67 mV dec^{-1}.

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