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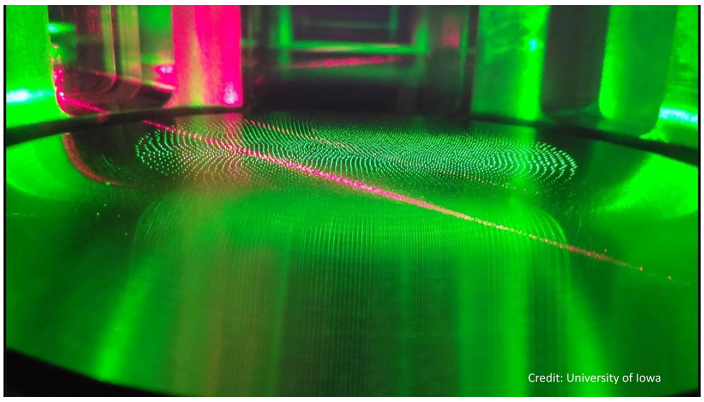
A carefully applied electric field can keep floating particles from causing defects in semiconductor devices.



Manufacturing semiconductor chips often involves plasma etching, where material from the surface is removed to create desired patterns. The removed material is mostly eliminated by a vacuum pump. Some of it, however, condenses into solid particles, which become electrically charged and remain suspended in the plasma. When the plasma current is shut off, these particles fall and cause defects on the chip.

Chaubey and Goree developed an experimental method to keep these particles suspended after plasma shutoff by applying an opposing electric field. Their setup was also used as an opportunity to study two-dimensional Coulomb expansion in the suspended particles.

In their experiment, the authors suspended fine particles in a two-dimensional plane inside a glow-discharge plasma. The applied electric field could be tuned to slow or reverse their descent. In the first case, this allowed the pair to study the rate the particles moved apart due to their electric charge. In the second case, the researchers could entirely prevent the particles from landing.

“We had two goals here,” said author John Goree. “One was for fundamental science for the Coulomb expansion. And the other one was for an engineering application for semiconductor manufacturing.”

Their observations comprise one of the few studies on two-dimensional Coulomb expansion, which is typically studied in three dimensions. They developed an analytical model to fit their data that agrees strongly over short time scales.

The researchers plan to market their setup to semiconductor device manufacturers as a way to prevent defects, lower costs, and reduce waste.

Source: “Coulomb expansion of a thin dust cloud observed experimentally under afterglow plasma conditions,” by Neeraj Chaubey and J. Goree, *Physics of Plasmas* (2022). The article can be accessed at https://doi.org/10.1063/5.0112680.