Kramer, is devoted to the production of thin films of semiconductors and dielectrics by laser-induced evaporation (**5**, 978; 1970). Either a steadily emitting CO_2 laser or a pulsed ruby laser can be used; the laser can of course be outside the vacuum enclosure. Many III–V compounds, various chalcogenides and some refractory oxides have been produced. The CO_2 laser confers no particular advantages compared with conventional evaporation, but the ruby laser permits fairly fast deposition rates even of "difficult" materials and, in particular, allows preparation of thin films of compounds that normally evaporate incongruently; the method is an extremely rapid form of flash evaporation.

The same issue also contains a note by two Oxford scientists (B. A. Unvala and K. Pearmain, *J. Mater. Sci.*, **5**, 1016; 1970) on the growth of epitaxial layers of silicon on silicon, as widely used in present-day transistor technology, by ion-beam sputtering. Argon ions are used for bombardment, in conjunction with an apparatus the precise geometry of which is critical for best results. Highly perfect and pure silicon mesas, with sharply defined diode characteristics, can be produced, provided the substrate is protected from argon-ion bombardment. The technique is, it seems, particularly suitable for the deposition of epitaxial layers of compound semiconductors, notably GaAs.

ELECTRON BEAMS

Interaction with Light

by our Solid State Physics Correspondent

FROM the tide of theories springing up to explain the puzzling experiment of Schwarz and Hora (*Nature*, **225**, 15; 1970) the picture is emerging of an intriguing quantum phenomenon involving the interaction of light with electrons. Schwarz and Hora found that when laser light is shone down a thin sheet of dielectric with the electric vector of the light normal to the surface, a beam of electrons traversing the sheet becomes imprinted with the frequency of the light and deposits it later on a non-fluorescent screen. The dielectric must clearly play a vital part in the modulation process because a free photon cannot interact with a free electron without violating the conservation of energy and momentum. The exact form of the interaction and the mechanism of release of the light at the screen, however, remain something of a mystery. A. R. Hutson (*Appl. Phys. Lett.*, **17**, 343; 1970) has now produced a lucid argument to show that the Schwarz-Hora effect is basically a quantum effect and fundamentally different from the classical bunching of electrons which occurs in a klystron.

Hutson points out that the conservation of energy and momentum in the electron–photon interaction can be preserved if allowance is made for the existence of a travelling wave mode inside the dielectric sheet. An electron crossing the film can then absorb or emit a photon with the surfaces of the dielectric providing the necessary recoil momentum. Hutson has calculated the wave-function of an electron scattered by the vector potential of the guided mode from the Born approximation. He finds that the optical modulation of the electron appears through a part of the wave function which contributes a modulation of about 8 per cent in the charge density. This highlights the essential difference from the classical bunching in a klystron. In the Schwarz–Hora case the energy of the modulated electron is essentially unchanged by the interaction, the scattered wave function being made up of one part which has gained an optical quantum and another part which has lost one. In classical bunching it is the electrons themselves which either gain or lose energy in the interaction. Hutson points out that the coherence length of the electron relative to the wavelength of the beam is important for the Schwarz–Hora case.

Hutson takes issue with the classical type of mechanism proposed by Rubin (*JETP Lett.*, **11**, 239; 1970) for the emission of photons at the target. He argues that if the process were of a classical nature the relative brightness of the different spots on the non-fluorescent screen would be proportional to the squares of the ratios for the fluorescent screen, and scrutiny of the photographs of Schwarz and Hora shows that this was not so. L. L. van Zandt maintains that the observed intensities can be predicted by a quantum mechanism (*Appl. Phys. Lett.*, **17**, 345; 1970).

Uncertainty about how best to represent the role of the dielectric film is producing an interesting clash of opinions. Hutson claims that A. D. Varshalovich and M. I. D'yakanov (*JETP Lett.*, **11**, 594; 1970) have incorrectly derived the momentum conserving interaction with the dielectric sheet and that L. D. Favro *et al.* (*Phys. Rev. Lett.*, **25**, 202; 1970) have overlooked the crucial function of the dielectric film in momentum conservation. It would seem that the time is now ripe for some fresh experimental evidence to help prune down the network of possible explanations of the Schwarz–Hora effect.

SEISMOLOGY

Explosions beget Earthquakes

from our Geomagnetism Correspondent

FURTHER evidence for physical correlations between nuclear explosions and earthquakes has been obtained by the US Geological Survey's National Center for Earthquake Research in California. According to Dr J. H. Healy and Dr R. M. Hamilton, five underground nuclear explosions set off at the Nevada Test Site during the period December 1968 to March 1970 were each followed by a large number of small earthquakes, as recorded by a dense network of fourteen seismic stations close to the sites. The explosions monitored were Benham on December 19, 1968 (equivalent to an earthquake of Richter magnitude 6·3), Purse on May 7, 1969 (5·8), Jorum on September 16, 1969 (6·2), Pipkin on October 8, 1969 (5·5) and Handley on March 26, 1970 (6·5).

Each explosion initiated earthquake activity lasting at least several weeks and lying within eight miles of the sites, though in spite of this comparatively short distance there was a general tendency for the area of seismic activity to extend with time and for further bursts of activity to occur weeks and even months after the first. Seismic determination of fault movements left no doubt that the explosions caused the release of natural tectonic strain energy. Thus had there been no explosions, the earthquakes would not have occurred when they did.