later extended in various ways, for instance to test the effect of solute on the energy plots⁷.

Shirokoff and Erb¹ studied gold and silver on sodium chloride substrates (classical epitaxial combinations), and also on silicon substrates, using evaporated amor-

FIG. 2 Approximate epitaxy of diamond deposited on silicon. From ref. 12 (courtesy S. J. Bull).

phous carbon separators in the former case, and amorphous silica films grown *in situ* in the latter. The metals were evaporated into position and then melted there to form small spheres, which were sintered into position. The same X-ray approach as before was used to test for the nature and uniformity of epitaxy. The experiment therefore amounted to searching for cusps in the plot of specific energy against misorientation for phase interfaces (as distinct from grain boundaries in the original experiments). Erb used to be a collaborator of Gleiter, so the approach has a direct pedigree. The outcome, in brief, was that epitaxy was maintained in the presence of amorphous separators as thick as 200 Å, though the thicker the amorphous separator, the less distinct, statistically, was the orientation relationship.

The details of the specific orientations do not matter here; there are several distinct relationships between any one substrate/deposit pair. What is important is that the orientation relationships fell into two categories: those that are sensitive to the presence of separator layers, and those that are not.

The experiment puts an end to the suspicion that Distler's findings were due to pinholes, for three reasons: if there had been a few of these, only those microspheres that happened to coincide with a pinhole would be affected; the division of orientations into two families was analysed to show that this fact was inconsistent with direct substrate/deposit contact; and a Au-Si eutectic was observed when

Au and Si were in direct contact but not when a thin SiO₂ film was present.

Shirokoff and Erb go on to say that it is now high time to attempt to model how epitaxy can in fact work through the separator films. It is hard to see how a Distler-type electric field could achieve this effect when the deposit is a metal.

The role of amorphous separators in permitting (or even fostering) epitaxy has surfaced in the past few years in another connection: making thin diamond films on suitable substrates by thermally induced reaction of gaseous methane with hydrogen. One development of this technique is to attempt to make single-crystal diamond films for microelectronics, using a silicon single-crystal substrate: silicon and diamond share the same crystal structure and although they have very different lattice parameters, approximate epitaxy can be achieved⁸⁻¹⁰; the result is a polycrystalline film with nearly parallel orientations. It is necessary to apply an electric bias between the substrate holder and the plasma above the substrate, and to permit the favoured orientations to grow over a period of hours at the expense of less favoured orientations (Fig. 2).

These papers, but especially those by Stoner's group, claim that an essential part of the epitaxial nucleation of diamond grains on silicon is the formation of thin amorphous layers of silicon carbide, which have to act as intermediaries. The assertion has this year been queried by Yang *et al.*¹¹ who present evidence, in the form of high-resolution electron micrographs of a cross-section of a diamond deposit on silicon, that the amorphous silicon carbide layer has pinholes which permit direct contact between diamond and silicon in a few locations. This takes us back to the sceptics who contemplated Distler's surprising results. There is indeed nothing new under the Sun. □

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Personal décor

MANY cosmetic treatments claim to sink into the skin, with flattering, even dramatic, results. The only one which actually does so is tattooing. Painfully, point by point, it implants a permanent image under the subject's skin. Daedalus is now improving the process.

He is combining two modern inventions, the spray immunizer and the ink-jet printer. The spray immunizer fires a shot of vaccine at the skin with such force that it penetrates the epidermis and is deposited just under the skin. Unlike conventional needle injection, the process is rapid and does not hurt. The ink-jet printer, of course, builds an image from tiny ink drops ejected under computer control. DREADCO engineers are now combining the two into a computer-controlled 'Skinwriter'. Its flexible graphics software can optimize any image on screen; its contour-following print head, mounted on an articulated arm, can transfer that image in full colour and on any scale to any part of the customer's anatomy.

The slow and painful process of traditional tattooing will be replaced by a swift, painless scan taking less than a minute. But the DREADCO Skinwriter is not confined to the limited market for decorative dragons, hearts and roses. Daedalus hopes that it will transform conventional cosmetics as well.

The thinning of the ozone layer poses a worldwide dermatological threat. The Skinwriter could literally save our skins by implanting the lighter of us with a permanent, ultraviolet-absorbing tan. The usual brownish colour should be popular; but for those who wish to remain pale and interesting, a pure colourless ultraviolet absorber, essentially a lifelong sunblock, could be implanted.

More complex treatments would be just as simple. Pallid beauties could have the roses permanently restored to their cheeks, and would-be tough guys could be given an ingrained 5 o'clock shadow. Even wrinkles might be countered. The great ladies of the past enhanced their legendary complexions with arsenic. Daedalus reckons that it combined with the sulphhydryl groups of their dermal collagen, preventing these groups from crosslinking to each other to embrittle and wrinkle the skin. An arsenical Skinwriting ink could do this job even better. Fortunately, the intradermal region cannot easily clear away foreign material (which is why tattoos are stable). Firmly bound to the local collagen, the arsenic could not wander off into the body and cause trouble elsewhere. The secret of eternal youth may be a light implantation of arsenic. David Jones