fluence (9×10^{15} cm^{-2}) and at a variable impinging energy (in the range 20–45 keV), puts in evidence the possibility to amorphize only above a critical threshold. The position of the amorphized regions also suggests that amorphization can take place only where sufficiently energetic recoils are produced. The existence of point defects out of the amorphized regions and their progressive involvement causes superlinear amorphization effects. This mechanism is viewed, in the framework of this model, as a decreasing of the amorphization threshold energy, because of the releasing of the residual energy by the involved point defects. The predictions of the model are compared with the experimental data referring to N^+ implanted into (111) silicon at 40 keV, and the resulting agreement is quite satisfactory.
G F Cerofolini et al, *J appl Phys*, **63,** 1988, 4911–4920.

31
6601. Observation of a dose-rate dependence in the production of point defects in quartz
Electron-spin resonance (ESR) has been used to monitor the growth of aluminum-associated trapped-hole centers (i.e., $[AlO_4]^0$ centers) in high-purity cultured quartz during a sequence of irradiations with 1.7-MeV electrons. Production curves were obtained at three dose rates (3.6, 36, and 360 krad/min) for a series of crystals furnished by three commercial growers of quartz. The shape of each curve depended directly on the dose rate and the origin of the quartz; many of them had an initial rapid growth to a maximum concentration followed by a 5%–25% decrease as the number of defects aproached an equilibrium value at a higher dose. We suggest that the complex shapes of these defect production curves, and also their variation between samples, is caused by a competition between the formation of $[AlO_4]^0$ centers and the formation of $[AlO_4/H^+]^0$ centers. At higher dose rates, in the 4–40 Mrad/min range, no dependence on dose rate was observed.
M A Mondragon et al, *J appl Phys*, **63,** 1988, 4937–4941.

31
6602. Implant-dose mapping using infrared transmission
Infrared transmission can be used for quantitative, nondestructive mapping of the dose distribution of Si^+ implants into GaAs wafers prior to annealing. Calibration curves of absorption exponent (the product of the absorption coefficient and the layer thickness) as a function of total implant dose have been obtained for representative implant schedules. Wafer maps are presented which illustrate the results for both normal implants and severely channeled implants.
Steven K Brierley et al, *J appl Phys*, **63,** 1988, 5085–5087.

31
6603. Residual defects in silicon after As^+ ion implantation at self-annealing regimes
Rutherford backscattering (He^+, 700 keV) and transmission electron microscopy were used to investigate the character of radiation damage in Si (001) after complete regrowth of the amorphous layer. Silicon samples were implanted with 120 keV As^+ ions at a dose rate ~ 50 mA/cm^2. It is shown that the formation and growth of inclusions takes place within a depth of 35–150 nm from the surface at the fourth stage of high current density implantation. These inclusions are coherent with the single crystal matrix and have a wurtzite-type hexagonal structure with the lattice parameters $a = 3.80$ Å and $c = 6.28$ Å. Approximately 40 nm of the surface silicon layer retains its perfect single crystal structure after implantation. By the end of the third stage of high current density implantation silicon crystals contain very few point defects (less than 5%) within a depth between $\bar{R}_p$ and $2\bar{R}_p$.
F F Komarov et al, *Radiat Effects*, **105,** 1987, 79–84.

31
6604. Silicon amorphization during heavy ion implantation—Part II
The silicon amorphization process during heavy ion implantation is considered. Expressions are derived for the critical doses, φ_0 and φ_{CT} for silicon amorphization at low and room implantation temperatures, respectively. Silicon amorphization doses are calculated for Kr^+, Xe^+, Nd^+, Yb^+, and Hg^+ ions, φ_0 is shown to decrease by a factor of 1.5 to 2 in the energy range 10 to 100 keV, and with further increase in energy φ_0 is shown to remain constant. At low energies $E \lesssim 40$ keV critical doses for silicon amorphization depend weakly on ion mass and implantation temperature (in the range 100 to 300 K). The value of φ_{CT}/φ_0 increases with energy and decreases with increasing implanted ion mass. The results of calculations agree well with experimental data.
U Yarkulov, *Radiat Effects*, **103,** 1987, 135–139.

31
6605. Ion implantation in glasses and concomitant effects
Various ions with energies of 30–400 keV, doses of $6.2 \cdot 10^{15}$–$6.2 \cdot 10^{16}$ ion/cm^2, and current densities of 1–10 μA/cm^2 were implanted in silicate glasses. Ion bombardment markedly altered the near-surface glass layer. The contributions of complicated physical–chemical processes to the resultant modification of the structure and properties of the glasses, in particular the contribution of chemical effects were determined. Antireflection in the IR range and long-range interaction were observed in ion-implanted glasses.
A A Deshkovskaya, *Radiat Effects*, **103,** 1987, 149–156.

31
6606. Depletion of carbon in UHMW PE due to 340 keV D^+ implantation
Depletion of carbon in Ultra High Molecular Weight Polyethylene (UHMW PE) as a result of its radiolysis due to 340 keV D^+ ion implantation up to a fluence of 1.8×10^{16} cm^{-2}, has been observed by using the same beam in the RBS mode. Prolonged vacuum aging of the irradiated sample at room temperature does not show any further carbon (C) depletion which suggests the formation of low molecular weight fragments only, escaping instantaneously out of the sample. This has been explained on the basis of crystalline structure of UHMW PE. Unexpectedly low ($\simeq 20\%$) C-depletion even at such a high dose (1000 M Gy) is explained on the basis of possible recombination of the radiolytically broken C–C bonds in the lamellar lattice. The C-depletion profile deduced from the Rutherford Back Scattering (RBS) spectra is unexpectedly Gaussian-like.
U K Chaturvedi et al, *Radiat Effects*, **104,** 1987, 43–50.

31
6607. Build-up and annealing of damage produced by low-energy argon ions at Si(111) surface
The amount of argon trapped and various surface property changes produced by 750 eV argon ion bombardment of Si(111) are investigated using Auger electron spectroscopy, thermal desorption spectrometry and low-energy electron diffraction. Critical saturation doses and annealing temperatures are determined, indicating that the surface reaches damage saturation at lower doses and begins to reorder at lower temperatures than the underlying region.
A Taoufik et al, *Radiat Effects*, **104,** 1987, 117–125.

31
6608. Transient enhanced diffusion of ion-implanted boron in Si during rapid thermal annealing
Transient enhanced diffusion of ion-implanted boron at a dose of 10^{14} cm^{-2} during rapid thermal annealing has been studied. The boron diffusion coefficient of the enhanced diffusion arising from implantation damage decreases with time t in the form of $D_0 \exp(-t/\tau)$, where D_0 is the diffusion coefficient at $t = 0$ and τ is the lifetime of the point defect causing the enhanced diffusion. The temperature dependence of D_0 and τ is revealed, and the point defect causing the transient enhanced diffusion is shown to be a vacancy. It is shown that final profile broadening due to the enhanced diffusion is smaller for higher temperatures. Furthermore, it is found that both D_0 and τ increase with an increase in implantation energy.
Masayasu Miyake and Shinji Aoyama, *J appl Phys*, **63,** 1988, 1754–1757.

31
6609. Neutron radiation effects in GaAs ion-implanted metal-semiconductor field-effect transistors
Neutron radiation investigations have been carried out on ion-implanted GaAs metal–semiconductor field-effect transistors (MESFETs). Device characteristics were measured before irradiation and following neutron irradiations with fluences from 5×10^{13} to 2×10^{15} n/cm^2. At 5×10^{13} n/cm^2, the device degradation is negligible, while at 2×10^{15} n/cm^2 the threshold voltage shift was 0.7 V and the device transconductance was 30% of its original value. Degradation parameters needed to explain these results are larger than what has been previously reported; this discrepancy is, in part, due to the nonuniform doping profiles in the FET channel. The details of a new model applicable to nonuniform carrier distributions and to density dependent carrier removal rates are presented and results compared to those in the literature. A carrier removal rate of approximately 20 cm^{-1} is required to explain the degree of observed device degradation.
B K Janousek et al, *J appl Phys*, **63,** 1988, 1678–1686.