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(Invited)

Silicon Graphoepitaxy*

Michael W. GEIS, Dale C. FLANDERS, Donald J. SILVERSMITH,
Dimitri A. ANTONIADIS† and Henry I. SMITH†
Lincoln Laboratory, Massachusetts Institute of Technology
Lexington, Massachusetts 02173 U.S.A.

Many researchers have observed that the nucleation, growth and orientation of crystalline films on a substrate surface are strongly affected by perturbations such as scratches, pits or natural relief steps. Graphoepitaxy makes use of artificially produced surface patterns to induce orientation in an overlayer.[1-7] Uniformly oriented films of silicon have been obtained on amorphous fused silica substrates by means of graphoepitaxy. The process used initially included forming a relief structure of square-wave profile in the fused silica substrate, depositing amorphous silicon over this relief structure, and then crystallizing the amorphous silicon with an argon laser beam. Silicon films formed by this process were mosaics of crystallites. The <100> directions of the crystallites were perpendicular to the substrate to within $\pm$ 2.5° and parallel to the grating axes to within $\pm$ 8.0°, as determined by x-ray pole plotting. The Hall mobilities of electrons in laser crystallized graphoepitaxial silicon films, 0.5 μm thick, ranged from 325 to 980 $cm^2/Vsec$, at a doping level of 5-8 x $10^{16} cm^{-3}$. By comparison, we measured electron Hall mobilities of 320 $cm^2/Vsec$ in commercial silicon-on-sapphire of the same thickness doped to 2 x $10^{16} cm^{-3}$. Recently, a new process for achieving silicon graphoepitaxy has been developed which yields improved crystallographic quality. With this process we have obtained silicon films in which the <100> directions are perpendicular to the substrate to within $\pm$ 0.25° and parallel to the grating axes to within $\pm$ 3.0°. Furthermore, the surface roughness and microcracks that we observed in laser crystallized films are not present with the new process. N-channel polysilicon gate field effect transistors have been fabricated in graphoepitaxial silicon films produced by this new process. Surface mobilities of 400 $cm^2/Vsec$ have been measured. The current status of the theory of graphoepitaxial orientation will be discussed with emphasis on methods for orienting silicon over insulating substrates. We believe graphoepitaxy is a very general technique that can be used to orient a wide variety of crystalline overlayer films on a variety of substrates.

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†Also, Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 U.S.A.

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