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Invited

Laser Assisted CVD Process for VLSI Microfabrication*

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Summary

In this paper, we will review the technology and potential roles of laser direct writing in the processing of advanced integrated electronics. Laser direct writing uses light-enhanced chemical reactions to dope, etch, or deposit electronic materials. Laser writing has been used, for example, to repair photolithographic masks and to connect and disconnect devices on integrated circuits.

Laser direct writing can be accomplished by a wide variety of chemical mechanisms which depend on the nature of the substrate, the reagents, and the laser wavelength being used. In this paper, we will discuss the two dominant approaches: directly initiated photochemical reactions ("photolytic") and laser-driven thermal reactions ("pyrolytic" or "CVD"). The former requires the use of an ultraviolet wavelength laser to sever bounds in the ambient gas or adsorbates. The latter requires that the substrate be locally heated, which then, in turn, initiates a local chemical reaction. Both techniques are capable of processing at the submicrometer-scale size with useful writing rates. Nonetheless, there are significant differences between the demonstrated capabilities of the two processes in terms of writing rates, materials properties and workable material systems. A review of the two technologies will be presented in our talk.

An unique feature of direct writing is that it is maskless. This capability allows one to write on a substrate or circuit without preparation. As a result, discretionary or custom operations are possible. Since the light beam interacts with only one region of the substrate surface, processing chemistry and associated contamination or damage in the remainder of the wafer does not occur. This characteristic is particularly important in photolithographic mask and integrated-circuit repair since existing techniques tend to damage other regions of the wafer during repair. Our talk will present examples of these two applications.

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In many cases the maskless nature or laser processing can be monitored or controlled in real time. An example is the fabrication of submicrometer optical diffraction gratings and through-wafer via holes on compound semiconductors. The optical properties of the gratings, which are made by an interferometric-process closely akin to direct writing, can be sensitively monitored and controlled by measuring the backscattered minus one diffraction order during fabrication.

Finally, for direct writing which is based on photochemically-initiated reactions, it is possible to obtain extremely low process temperatures. As a result, direct writing can be demonstrated on a host of materials not normally accessible to microelectronics fabrication techniques. As an example, we have recently demonstrated that it is possible to write metal lines on low and high temperature polymeric substrates.