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Ultra high pulse repetition frequency laser irradiation for in-depth melting and subsequent flawless solidification of semiconducting material

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An Ultra High Pulse Repetition Frequency (UHPRF) or Quasi Continuous Wave (QCW) laser was elaborately controlled and irradiated on semiconductor layer steering bottomless melting of the void material to eventually aim at dense solidification. A massive deposition of amorphous semiconductor, interconnection purpose for instant leads great number of defects and sizable voids which would result in degradation of electrical performances of the device. There are numerous trials to remove or minimize such drawback by means of physically trampling flaws by deposition of heavier atomic material otherwise pulsed laser irradiation which intends to do fully packed solid transformation of the molten layer during solidification. In the case of photonic way, it is crucial to secure sufficient laser pulse duration with energetic intensity simultaneously which is contradictory since high pulse energy from the laser is the outcome of extraction of laser light in very short period of time. Either insufficient light intensity or short of pulse duration will cause shortage in melt volume, so the defects and voids may not fully be covered. On the other hands, UHPRF laser emits selected wavelength of light ranging from ultra violet to green with the pulsing period of 10 nanoseconds to 50 nanoseconds. Laser pulses come out extremely fast, so there is no time allowed the material to undergo cooling and on the contrary, accumulation of successive laser energy while the material is remained yet in liquid phase would effectively work to homogenously melt the entire material in depth. We have demonstrated complete melting followed by firm recrystallization result originally starting from 400 nm a-Si via cross section TEM and diffraction pattern measurement which proves dense transformation. Carefully manipulating key parameters would contribute for taking good control of melt depth, melt degree, surface roughness, etc. Melting, annealing and recrystallization sort of semiconductor heat treatments can be appropriately applicable with it.

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