Optical Properties of Molecular-Beam-Epitaxy Deposited Amorphous Silicon

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Amorphous silicon continues to be the focus of considerable attention owing to its remarkable potential for electron device applications. At present, device-quality amorphous silicon is usually prepared through the plasma decomposition of silane gas [1], the resultant material being a mixture of silicon and hydrogen atoms. It is widely held that the hydrogen atoms that exist within this material are responsible for its favorable electronic properties [2,3]. Unfortunately, these hydrogen atoms are also believed to be responsible for the deterioration in the electronic characteristics that occurs upon exposure to light [4-6]. This has encouraged researchers to seek alternate forms of amorphous silicon that retain the favorable electronic characteristics of conventional amorphous silicon without the large amounts of hydrogen. Recently, for example, Brockhoff *et al.* [7] prepared amorphous silicon thin-film transistors using hot-wire deposition, the resultant hydrogen content being an order of magnitude lower than that found in conventional amorphous silicon.

Molecular beam epitaxy, a technique that is presently being used in crystalline semiconductor epitaxial growth, affords a great deal of control over the deposition process, the thickness, composition, and impurity content of the resultant films that are being tailored to suit the needs of the specific application under consideration. We have employed molecular beam epitaxy to deposit thin films of amorphous silicon, which have 98% of the density of crystalline silicon [8]. Spectroscopic studies reveal that there are only trace amounts of hydrogen and other impurity atoms in this novel form of amorphous silicon, this contrasting dramatically with the case of conventional amorphous silicon. The Raman spectroscopic properties indicate that the disorder that exists in this material is somewhere between that exhibited by conventional amorphous silicon and sputtered amorphous silicon.

The primary aim of this study is to determine the optical characteristics of this novel form of amorphous silicon through measurements of the transmission and reflection spectra from 1-6 eV. The results obtained at higher energy are notably different from those found for other more conventional forms of amorphous silicon. Conclusions are made regarding optical evidence for the amount of disorder in the material. It is our eventual goal to use molecular beam epitaxy for the fabrication of amorphous-silicon based multilayer structures that are useful in the fabrication of light emitting and absorbing devices.

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