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Volume II: Materials and Device Physics

Jerzy Kanicki ▾ Editor

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Chapter 8

Amorphous-Silicon Thin-Film Transistors: Physics and Properties

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Thin-film transistors (TFT) made with hydrogenated amorphous silicon (a-Si:H) represent an interesting field of study for several reasons. First, there is fundamental interest in amorphous silicon itself. Because in TFTs the Fermi level in the amorphous silicon can be controlled at will, they can be used as powerful tools to investigate various material properties, including density-of-states distribution, photoconductivity, mobility, and stability. Second, interest in a-Si:H TFTs receives commercial impetus because of application in liquid crystal displays, image sensors, and printer arrays. Finally, the device physics of a-Si:H shows many similarities but also striking differences, with established (c-Si) device physics, thus proving useful by throwing established concepts into relief and adding new insight.

In this chapter we will discuss the application of a-Si:H TFTs, review theories and models that have been developed to describe the physics, and, finally, analyze in detail some special issues in the physics of a-Si:H TFTs.

The first section of this chapter gives a brief outline of the main applications of a-Si:H TFTs: liquid crystal displays, printer arrays, and image sensors. We will then discuss the structure and some technological aspects of the transistors. This will be done with reference to standard devices, but a discussion of important topics, such as alternative structures and the choice of gate insulator, is also included. In the third section, the device theory is discussed. Because amorphous silicon is characterized by a continuous distribution of localized states in which the space charge resides and because the distribution of localized states is not necessarily given by a simple expression, solutions of a complete and self-contained theory can only be calculated numerically with the aid of a computer. Here, we will discuss instead a simple model first to establish basic concepts. These will then be used in a qualitative discussion of recent theoretical developments in the literature. Fol-

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