sive state land use policy, the Land and Water Management Act, based on the ALI model code and concerned with the big cases, stands as a fair mark of Florida's present midway position on the long path toward such a policy. And, given the close conceptual linkage between this Florida law and the pending federal land use policy legislation, the limitations of that law are of national significance.

—LUTHER J. CARTER

Erratum: In the article by Luther J. Carter "Land use Law (I) . . ." (16 November), the last sentence in the second column on page 694 should read, "With some exceptions, little or nothing has been done by either federal or state government to cope with the ultimately more serious problem of protecting the land itself."—

RECENT DEATHS

Gordon Alexander, 71; retired head, biology department, University of Colorado, Boulder; 21 July.

Orville L. Bandy, 56; former chairman, geological sciences department, University of Southern California; 2 August.

Rolf L. Bolin, 72; professor emeritus of marine biology and oceanography, Stanford University; 22 August.

Lan Jen Chu, 59; professor of electrical engineering, Massachusetts Institute of Technology; 25 July.

Steve Pratt, 55; professor of psychology, Wichita State University; 28 July.

Wiley B. Sanders, 75; former professor of sociology, University of North Carolina; 10 August.

Howard V. Smith, 73; professor emeritus of agricultural chemistry and soils, University of Arizona; 10 August.

C. Martin Spooner, 71; retired chief, urology department, Toronto Western Hospital; 4 June.

Harold I. Tarpley, 75; professor emeritus of electrical engineering, Pennsylvania State University; 8 August.

T. Ivan Taylor, 63; professor of chemistry, Columbia University; 27 July.

James M. Williams, 97; professor emeritus of sociology, Hobart and William Smith Colleges; 7 August.

RESEARCH NEWS

Glassy Metals: No Longer a Laboratory Curiosity

Ever since a primitive blacksmith first discovered that quenching an alloy of iron and carbon with water could greatly increase the strength of the resulting steel, the world of the metallurgist has been heavily weighted toward the proposition that the most useful properties of metallic alloys often result when nonequilibrium structures are obtained. The principal means for obtaining such nonequilibrium structures has been some variation of the quenching process, that is, the cooling of an alloy so rapidly that the equilibrium structure characteristic of the lower temperature does not have time to form and the high-temperature structure is retained.

Now, the fascination of the materials scientist and solid state physicist with amorphous or noncrystalline materials in combination with the older metallurgical idea of quenching is giving rise to a class of solids known as amorphous metallic alloys or glassy metals. There is a growing interest among theoretical and applied researchers alike in the mechanical, magnetic, and electrical properties of these materials.

When a molten metal or metallic alloy is cooled, the solid phase formed is crystalline, with a structure that depends on the particular alloy composition. In contrast, molten glass-forming materials, when cooled, do not assume a crystalline structure, but instead retain a structure somewhat like that of the liquid—an amorphous structure. In each case, the thermodynamically stable or equilibrium structure at room temperature is crystalline. The difference between the two is in the kinetics or rate of formation of the crystalline phase, which is controlled by factors such as the nature of the chemical bonding and the ease with which atoms move relative to each other. Thus, in metals, the kinetics favors rapid formation of a crystalline phase, whereas in normal glasses the rate of formation is so slow that almost any cooling rate is sufficient to result in an amorphous structure. Glassy metals are formed when the molten metal is cooled sufficiently rapidly that crystallization is suppressed.

There are at least four methods of obtaining glassy metals, only one of which involves rapidly cooling, or quenching, a molten liquid, although all in effect quench by suppressing the rate of crystal formation. The other methods are vacuum evaporation, sputtering, and electrodeposition and "electroless" deposition. The first report of an amorphous metal produced by quenching was that by Pol Duwez' group at the California Institute of Technology, Pasadena; they obtained an amorphous alloy consisting of 75 percent gold and 25 percent silicon by propelling small molten globules against a thermally conductive metal substrate at high velocities. Amorphous specimens produced in this way were foils varying from less than 1 to a few micrometers thick. Alloys made by liquid quenching are limited to one of two groups. The first is composed of alloys made from either a transition or a noble metal and a smaller metalloid element, such as alloys of palladium and silicon or iron, phosphorus, and carbon. The second is composed of alloys made from transition metals only (intertransition metal alloys), such as copper-zirconium.

Vacuum evaporation, in which the starting alloy materials are vaporized by heating in some way and then deposited onto a substrate cooled to the temperature of liquid nitrogen (77°K) or below, is a method for producing thin films of amorphous metallic elements, as well as a wider variety of alloys than by liquid quenching. Sputtering, like vacuum evaporation, can be used to make a wide variety of alloy compositions. A target of the desired composition and a substrate are placed in an ionized gas (plasma) maintained by an electric field. The gas ions are accelerated toward and knock atoms from the surface of the target, which are deposited on the substrate to make a thin film with an amorphous structure. Electrodeposition (the familiar nickel-plating process) is used to make alloys of phosphorus and either nickel, iron, cobalt or palladium.