Detectors

Fiber Photodetectors Codrawn From Conducting, Semiconducting and Insulating Materials

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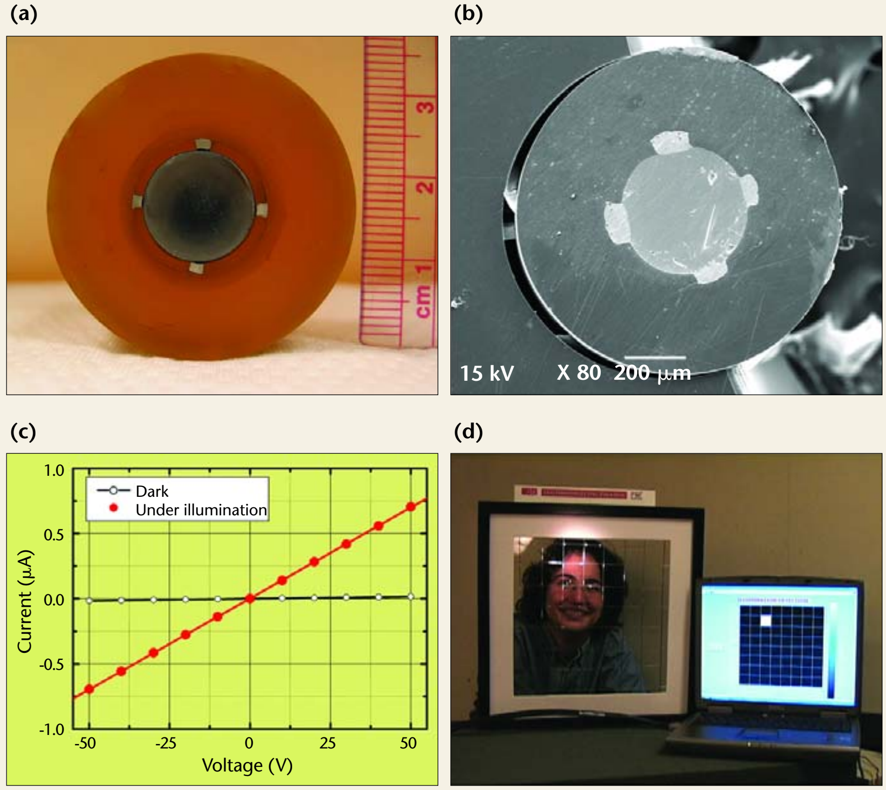

Figure 1. Fiber photodetectors. (a) Macroscopic preform consisting of a photoconductive core made of a chalcogenide glass ($As_{40}Se_{50}Te_{10}Sn_5$), surrounded by a polymer (PES) cladding. The core is contacted by four metal (Sn) electrodes that run along the length of the preform. (b) SEM micrograph of the fiber cross section demonstrating that the preform geometry has been preserved during the drawing process. (c) Measured current-voltage characteristics of a distributed metal-semiconductor-metal fiber photodetector in the dark and under illumination with white light (20 mW). (d) A 2D fiber web, assembled out of photodetecting fibers, detects the location of a beam of light.

A barrier has existed until recently between the fabrication technologies used to produce electronic devices and those used to produce optical fibers.[1, 2] The former comprise a collection of elaborate wafer-based processes while the latter rely on simpler preform thermal-drawing techniques. In a recent publication that describes how this barrier has been broken, we report on the first successful fabrication of functional optoelectronic devices using fiber drawing techniques.[3] These fibers are made by arranging a low-melting-temperature conductor (Sn), an amorphous semiconductor (As_2Se_3 or $As_{40}Se_{50}Te_{10}Sn_5$) [Ref. 4] and a high-glass transition thermoplastic insulator[5] [polyethersulfone (PES) or polyetherimide (PEI)] into a macroscopic preform which shares the final fiber geometry but lacks functionality because of the absence of intimate contact and proper element dimensions. The preform [33 mm thick; see Fig. 1(a)] consists of a cylindrical semiconductor chalcogenide glass ($As_{40}Se_{50}Te_{10}Sn_5$) core, contacted by four Sn metal conduits encapsulated in a protective PES cladding. This preform is subsequently heated and drawn into a fiber [980 μm thick; see Fig. 1(b)]. The resulting fiber exhibits electrical and optical functionalities which follow from the excellent contact, the appropriate element dimensions and the preservation of the preform geometry throughout the drawing process. Specifically, the electrical conductance of the fiber was found to increase dramatically (by two orders of magnitude) upon illumination by white light (20 mW), as seen in the large slope of the linear I-V curve when compared to that recorded in dark conditions [Fig. 1(c)].

While the individual fiber behaves as a distributed photodetector, with sensitivity to visible and infrared light at every point along its entire length, it is the assembly of such fibers into two-dimensional (2D) grids, or photodetector fiber webs, which enables the detection of an illumination point. Moreover, this grid achieves N^2 detection resolution with only a $2N$ number of elements. Figure 1(d) shows an example of a fiber web detector being used to measure the coordinates of an illumination point on a 30×30 cm^2 grid with 64-point resolution.

We expect that such metal, insulator and semiconductor flexible fibers will pave the way for the future development of fibers, and even fabrics, with novel optical and electrical properties.

Acknowledgments

This work was supported in part by DARPA/Carrano and DARPA/Griggs, DARPA QUIST, the ARO, the ONR, the AFOSR HEL-MURI, the U.S. DoE, the ISN and the Materials Research Science and Engineering Center (MRSEC) program of the NSF with use of their Shared Experimental Facilities.

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