ployed an electro-optic sampling technique (EOS).[5] An 80-Gbit/s electrical data signal, which is converted from the optical input data signal by the UTC-PD, was monitored beforehand using a separate UTC-PD. The input and demultiplexed output waveforms are shown in Fig. 3. The 80-Gbit/s data (10110100) were successfully demultiplexed into 40-Gbit/s data (0011) with a good extinction. The power consumption was extremely low at 7.75 mW at a clock bias voltage of 0.5 V.

In summary, an optoelectronic demultiplexing circuit, monolithically integrated with RTDs and UTC-PD, successfully demonstrated an ultrafast demultiplexing with extremely low power consumption.

**NTT System Electronics Laboratories*

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## CFB2 8:15 am

### High-speed resonant-cavity-enhanced Schottky photodiodes

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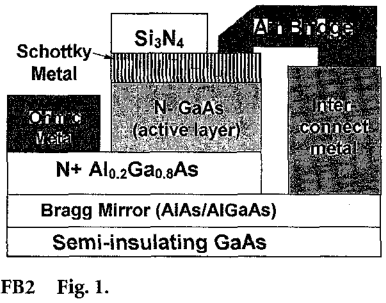
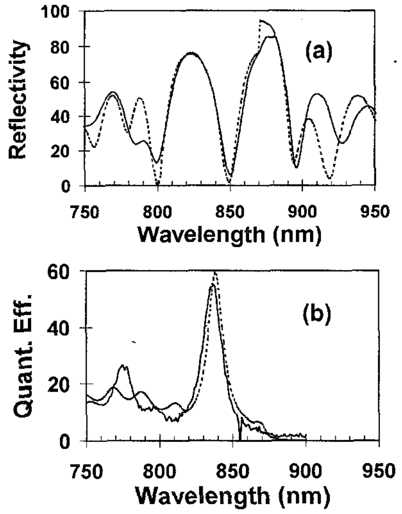
The bandwidth capabilities of optical-fiber telecommunication systems are still not fulfilled with present performances of optoelectronic devices.[1] Schottky photodiode, with 3-dB operating bandwidth exceeding 200 GHz, is one of the best candidates for high-speed photodetection.[2,3] However, like *p-i-n* photodiode, Schottky photodiode also suffers from bandwidth-efficiency trade-off. A recent family of, namely, resonant-cavity-enhanced (RCE) photodetectors has the potential to overcome this trade-off.[4,5] In this paper, we report our work on design, fabrication, and testing of high-speed RCE Schottky photodiodes.

The top-illuminated Schottky photodiodes were fabricated by a microwave-compatible monolithic microfabrication process. Figure 1 shows the schematics of the fabricated devices. Fabrication started with formation of ohmic contacts to $n^+$ layers. Mesa isolation was followed by a Ti-Au interconnect metallization. Then, a semitransparent Au Schottky metal and a silicon nitride layer was deposited. Besides protecting the surfaces, the nitride layer also served as an antireflecting coating and a dielectric for bias capacitors. Finally, a thick Ti-Au layer was deposited to form an air bridge connection between the interconnect and the Schottky metal.



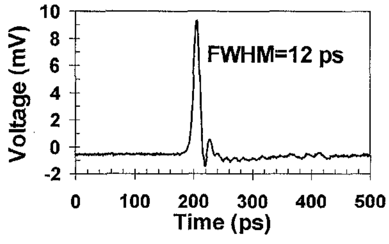
CFB2 Fig. 1.



CFB2 Fig. 2. The theoretical (dashed) and experimental (solid) comparison of (a) reflection properties and (b) quantum-efficiency characteristics of the photodiode.

We have used a transfer matrix method to simulate the optical properties of the photodiodes. Figure 2(a) shows the reasonable agreement between the theoretical and experimental reflection characteristics of the unprocessed RCE detector structure. Photospectral measurements were carried out by using a tungsten-halogen light source and a monochromator. Figure 2(b) shows the theoretical and experimental quantum efficiency characteristics of the fabricated devices. The resonant wavelength of the devices were close to the design wavelength of 840 nm, along with an enhancement factor around 11. The peak quantum efficiency at resonance was 55%, while the predicted quantum efficiency was 60%.

High-speed measurements of the samples were made with 1-ps optical pulses obtained from a Ti:sapphire laser operating at 840 nm. Figure 3 shows the temporal response of a small-area (10 × 10 μm) photodiode measured by a 50-GHz sampling scope. The measured photodiode output has a 12-ps FWHM. The Fourier transform of the data has a 3-dB bandwidth of 40 GHz. The measurement was limited by the experimental setup. By deconvolving the response of the scope, we predicted the photoresponse to be close to 100 GHz. To our knowledge, our results correspond to the fastest RCE photodetectors published in scientific literature.



CFB2 Fig. 3. Pulse response of RCE Schottky photodiode.

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## CFB3 8:30 am

### The photomixer transceiver

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In the time domain, terahertz photoconductive sampling has been used by many groups for spectroscopy in free space and on transmission lines over several THz of instantaneous bandwidth. These systems consist of two fast photoconductive switches that are excited by a mode-locked laser and are coupled to each other via antennas or transmission line.

In the frequency domain, photomixers that use low-temperature-grown (LTG) GaAs photoconductors illuminated by two cw diode lasers have generated cw difference-frequency radiation from 200 MHz to 5 THz.[1] These sources have application as local oscillators[2] and for high-resolution gas spectroscopy when coupled to a cryogenic detector such as a bolometer.[3]

Until now, there has not been a demonstration of photoconductive sampling using photomixers. This paper describes a general technique for performing photoconductive sampling in the frequency domain. For spectroscopy applications that require narrow-resolution linewidth (<1 MHz), this technique can offer significant improvement over time-domain sampling in spectral brightness (~$10^6$ times higher). Furthermore, the system is coherent, widely tunable, and can be compact—using inexpensive diode lasers that are fiber coupled to photomixer transmitter and receiver chips.

Figure 1(a) shows a block diagram of how narrow-linewidth spectroscopy could be performed coherently and at room temperature using antenna-coupled photomixers as the transmitter and receiver. Figure 1(b) shows the experimental setup that was used to test the concept at microwave frequencies. The combined light from a pair of distributed-Bragg-