Interim Status Report No. 3

SEMICONDUCTING TRANSITION METAL SILICIDES
FOR ELECTRO-OPTIC VLSI INTERCONNECTS

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During the period since the last progress report, we have optically
categorized the CrSi$_2$ samples, and fabricated thin films of MnSi$_{1.7}$ and
IrSi$_{1.7}$. X-ray analysis of the latter two silicides has also been
accomplished. These developments are summarized below.

Optical Characterization of CrSi$_2$

The spectral reflectance and transmittance of a representative sample are
shown in Figure 1. A forbidden energy gap of ~0.3 eV is obtained from the
onset of strong absorption at that energy. The interference fringes
are a product of the refractive index and film thickness, and the
estimated film thickness of 2.4 microns gives a refractive index of
approximately 4.2 below the absorption edge. The strong absorption for the
film above the absorption edge indicates an absorption coefficient of
approximately $3 \times 10^3 \text{cm}^{-1}$. Because of this relatively low value of absorption
coefficient, we tentatively identify the forbidden energy gap as of the
indirect type. Computer analysis of the data is in progress.

MnSi$_{1.7}$ Formation and Analysis

Thin films of this material were formed by ion beam sputtering and
furnace reaction techniques as described for CrSi$_2$ in our first progress
report. X-ray diffraction analysis of the films confirms the presence of the
semiconducting manganese silicide, with no other detectable phase except the
silicon substrate. A diffraction pattern for a 1.5 micron-thick film is shown
in Figure 2. Peaks belonging to the semiconducting manganese silicide phase
are indicated, but the pattern cannot be indexed because the crystal structure
is unknown. Different textures were observed for the three substrate types (1-0-0 and 1-1-1 silicon, and polysilicon-coated wafer).

The room temperature resistivity of the material is 0.04 ohm-cm. Samples formed at 1000°C exhibit a photoconductivity, upon illumination with a 6V microscope lamp, of about 0.04% of the dark conductivity. Preliminary transmittance measurements indicate a bandgap somewhat larger than that of the chromium disilicide.

IrSi$_{1.75}$ Formation and Analysis

A representative X-ray diffraction pattern for a film formed at 750°C is shown in Figure 3. Again, the data indicate the well-crystallized semiconducting silicide phase and no other except for the silicon substrate.

The room temperature resistivity for this material is on the order of 0.15 ohm-cm, with a photoconductivity as measured above of about 0.3% of the dark conductivity. Preliminary transmittance measurements also indicate a bandgap somewhat larger than that of the chromium disilicide.
X-RAY DIFFRACTION PATTERN

MANGANESE SILICIDE

(Diffraction Intensity (arb.))

$2\theta$ (Degrees)

(MnSi$_{1.7}$ peaks are circled)
X-RAY DIFFRACTION PATTERN

IRIDIUM SILICIDE

(\(I_{-Si_{1.75}}\) peaks are circled)
END

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