on the electron source side and the desired higher pressure in the sample-exchange chamber. In the original intended application of the MEMSA, the PLAs would be four platinum disks containing apertures of ~0.5-mm diameter, chosen to maintain a pressure between 5 and 7 torr (about 0.67 to 0.93 kPa) of residual Martian atmospheric gas comprising primarily CO₂.

The MEMSA is expected to be capable of imaging at a spatial resolution of 40 nm or finer without EDX, or imaging at somewhat coarser resolution (of the order of 200 nm) with EDX in the energy range from 100 to 20 keV. The coarsening of resolution in the case of EDX would be a consequence of the need to use higher electron current. The maximum power demand of the MEMSA during operation has been estimated to be ~5 W.

This work was done by Harish Manohara, Gregory Bearman, Susanne Douglas, Michael Bronikowski, Eduardo Urgiles, and Robert Kowalczyk, of Caltech and Charles Bryson of Apperati, Inc. for NASA’s Jet Propulsion Laboratory.
Electron-Spin Filters Would Offer Spin Polarization >1

Net spin flux could be generated with little net electric current.

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A proposal has been made to develop devices that would generate spin-polarized electron currents characterized by polarization ratios having magnitudes in excess of 1. Heretofore, such devices (denoted, variously, as spin injectors, spin polarizers, and spin filters) have typically offered polarization ratios having magnitudes in the approximate range of 0.01 to 0.1. The proposed devices could be useful as efficient sources of spin-polarized electron currents for research on spintronics and development of practical spintronic devices.

The polarization ratio in question — denoted the current spin polarization — is a standard measure of efficiency of a spin-polarizing device. It is defined in terms of current densities along a given coordinate axis, by means of the following equation:

\[ P_J = \frac{J_↑ - J_↓}{J_↑ + J_↓}, \]

where \( J_↑ \) is current density of electrons in the “up” spin state and \( J_↓ \) is the current density of electrons in the “down” spin state. If \( J_↑ \) and \( J_↓ \) can be made to have opposite signs — in other words, if electrons in opposite spin states can be made to move in opposite directions — then, as desired, it is possible to obtain \( |P_J| > 1 \). By making \( |P_J| > 1 \), one would make it possible to obtain a net spin flux with little net electric current.

A spin-polarizing device according to the proposal would be based largely on the same principles as those of the devices described in "Electron-Spin Filters Based on the Rashba Effect" (NPO-30635), NASA Tech Briefs, Vol. 28, No. 10 (October 2004), page 58. To recapitulate: The Rashba effect is an energy splitting, of what would otherwise be degenerate quantum states, caused by a spin-orbit interaction in conjunction with interfacial electric fields in an asymmetrical semiconductor heterostructure. The magnitude of the energy split is proportional to the electron wave number. Theoretically, electron-energy states would be split by the Rashba effect, and spin-polarized currents would be extracted by resonant quantum-mechanical tunneling. Accordingly, a spin-polarizing device based on these principles would be denoted an asymmetric resonant interband (or intraband, as the case may be) tunneling diode [a-RITD].

One possible structure of a device according to the present proposal would be similar to the a-RITD structure described previously: The device would comprise an asymmetric composite InAsGaSb well, sandwiched between A1Sb barriers and degenerately-doped InAs emitter and collector electrodes (see figure). Unpolarized electrons from the conduction band of the InAs emitter electrode would tunnel through one A1Sb barrier and travel through an asymmetric InAsGaSb quantum well, where Rashba spin splitting would occur; they would then tunnel through the other A1Sb barrier into the conduction band of the InAs collector electrode. The device would be operated in an intraband-tunneling regime, in which no bias would be applied through the thickness of the stack of layers. A lateral electric (an electric field parallel to the planes of the layers) would be applied to emitter layer. With appropriately chosen thicknesses of layers and an appropriate value of the applied lateral electric field, it should be possible to achieve \( |P_J| > 1 \).

This work was done by Brian Hunt, Michael Bronikowsky, Eric Wong, Paul von Allmen, and Fabiano Oyafuso of Caltech for NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).