If L is assumed to drift slowly, then it is necessary to postpone calculation of q_i until after a second radiosonde campaign. In this case, one obtains a new value, L_2, from the second radiosonde campaign, and for the ith routine off-campaign measurement run, one uses an intermediate value of L obtained by simple linear time interpolation between L_1 and L_2.

This work was done by Thierry Leblanc and Iain S. McDermid of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-45955

Bimaterial Thermal Compensators for WGM Resonators

Net thermal drifts of spectra would be cancelled to first order.

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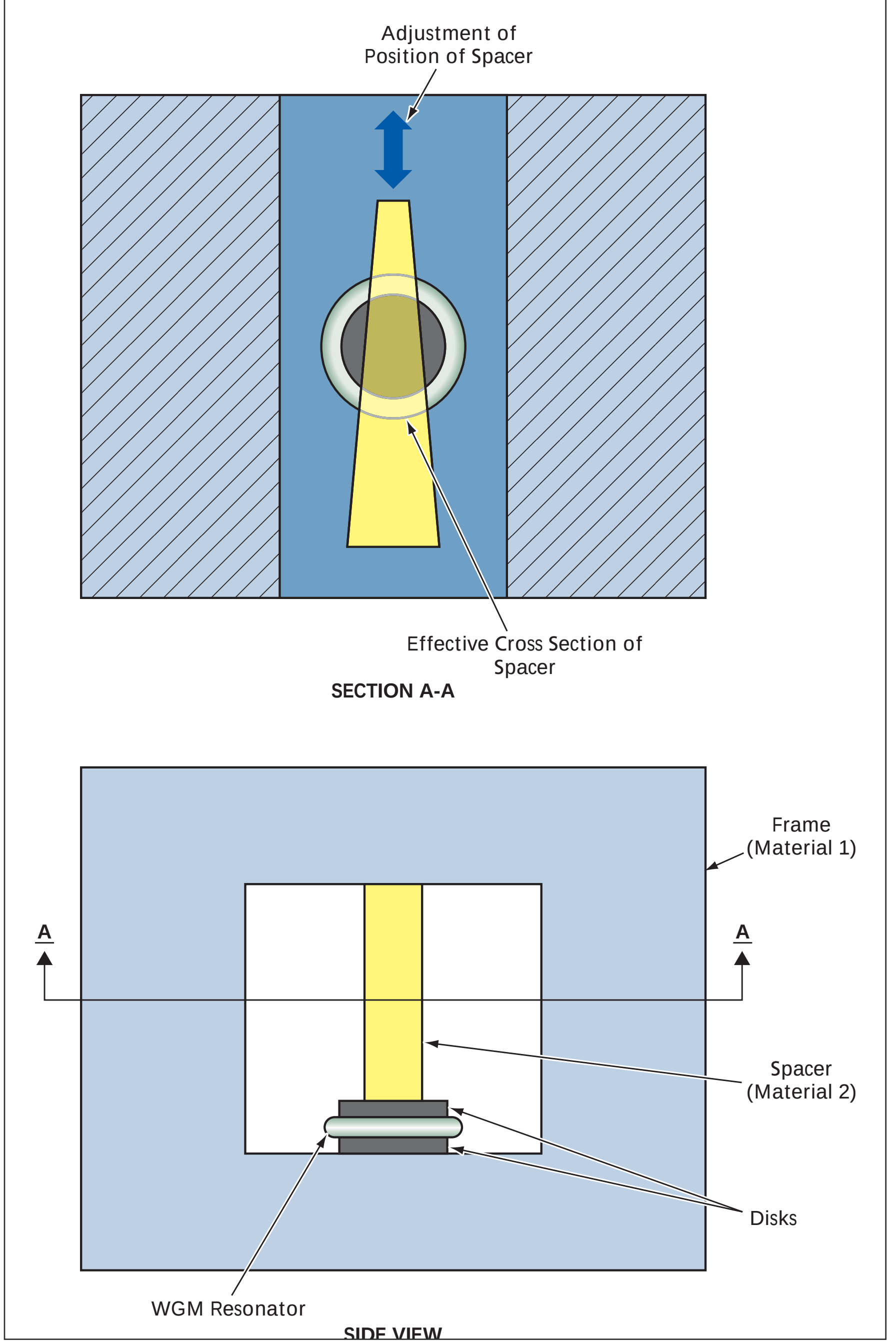

The **Bimaterial Compensator** would apply a temperature-dependent stress to counteract the temperature dependence of the spectrum of the uncompensated resonator.

Bimaterial thermal compensators have been proposed as inexpensive means of preventing (to first order) or reducing temperature-related changes in the resonance frequencies of whispering-gallery-mode (WGM) optical resonators. A bimaterial compensator would apply, to a WGM resonator, a pressure that would slightly change the shape of the resonator and thereby change its resonance frequencies. Through suitable choice of the compensator dimensions and materials, it should be possible to make the temperature dependence of the pressure-induced frequency shift equal in magnitude and opposite in sign to the temperature dependence of the frequency shift of the uncompensated resonator so that, to first order, a change in temperature would cause zero net change in frequency.

A bimaterial compensator as proposed (see figure) would include (1) a frame made of one material (typically, a metal) having a thermal-expansion coefficient α_1 and (2) a spacer made of another material (typically, a glass) having a thermal-expansion coefficient α_2. The WGM resonator would be sandwiched between disks and the resulting sandwich would be squeezed between the frame and the spacer (see figure). Assuming that the cross-sectional area of the frame greatly exceeded the cross-sectional area of the spacer and that the thickness of the sandwich was small relative to the length of the spacer, the net variation in a resonance frequency as a function of temperature would be given by

$$df/dT \approx \partial f/\partial T + (\partial f/\partial F)S_2E_2(\alpha_2 - \alpha_1)$$

where f is the resonance frequency, T is temperature, $\partial f/\partial T$ is the rate of change of frequency as a function of temperature of the uncompensated resonator, $\partial f/\partial F$ is the rate of change of frequency as a function of applied force F at constant temperature, S_2 is the effective cross-sectional area of the spacer, and E_2 is the modulus of elasticity of the spacer.

Through appropriate choice of materials and geometry, one could obtain temperature compensation — that is, one could make $df/dT \approx 0$. For example, the effective spacer cross-sectional area for temperature compensation is given by

$$S_2 \approx (\partial f/\partial T) / [(\partial f/\partial F) E_2(\alpha_1 - \alpha_2)].$$

Because it would be exceedingly difficult to fabricate the spacer to the precise required cross section, the spacer would have a wedge total cross section extending beyond the disk diameter, so that the effective cross section could be varied by moving the spacer. As part of the process of fabricating the temperature-compensated WGM resonator, the resonator-and-compensator assembly would be installed on a thermoelectric cooler, which would be used to impose an oscillating temperature on the resonator. The resulting synchronous oscillation of the optical spectrum of the resonator would be monitored on an oscilloscope. The position of the spacer would be shifted in small increments until the synchronous oscillations of the spectrum were reduced to zero.

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