Gas-phase Electron Resonance Spectra of SF, SeF, SeO ($^3\Sigma$ and $^1\Delta$) and IO

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WE report the detection of the gas-phase electron resonance spectra of SF, SeF, SeO ($^3\Sigma$ and $^1\Delta$), and IO. Using techniques which have been described elsewhere,[1] we have studied reactions between atoms and secondary gases, the mixing occurring inside the electron resonance microwave cavity.

SF, SeF, and IO have $^2\Pi_{3/2}$ ground states and we detect the spectra of molecules in the lowest rotational level, with $J = 3/2$. SF and SeF were obtained by reaction of fluorine atoms (produced by passing CF_4 through a microwave discharge[2]) with OCS and OCSe respectively. Both spectra consist of six lines occurring between 7500 and 8500 gauss (microwave frequency $\sim$ 8700 Mc./sec.), which arise from the second-order Zeeman splitting and the ^{19}F hyperfine interaction (nuclear spin $\frac{1}{2}$). The spectrum of IO was observed by reaction of oxygen atoms with CF_3I, and consists of eighteen lines, arising from the second-order Zeeman splitting and nuclear hyperfine splitting from ^{127}I (nuclear spin 5/2). Analysis of these three spectra yields the rotational constants B_0 (and hence the bond lengths); we are also able to observe Stark splittings in the spectra[3] and hence the electric dipole moments will be measurable. In each case we obtain the magnetic hyperfine component along the internuclear axis,[4] and for IO the ^{127}I electric quadrupole coupling constant is also determined. The radicals SF and SeF do not appear to have been detected previously by any physical method.

The spectrum of SeO was observed by reaction of OCSe with the products of a microwave discharge in O_2. Four lines between 9 and 10 kilogauss arise from SeO in its excited $^1\Delta_2$, $J = 2$ state and the separation between them yields the rotational constant. In the case of SeO in its $^3\Sigma$ ground state we observe a group of four lines arising from the Zeeman components of the $J = 1$, $K = 2 \longleftrightarrow J = 1$, $K = 1$ transition.

All of the spectra described in this note, except that of $^3\Sigma$-SeO, show a first-order Stark effect and were detected using a microwave cavity which employs 100 kc./sec. Stark modulation.[3,5] $^3\Sigma$-SeO has only a second-order Stark effect and was therefore detected using a 100 kc./sec. Zeeman-modulated cavity.[6]

The Table presents a brief summary of the gaseous free-radicals which have so far been detected by electron resonance.

TABLE

Summary of gaseous free-radicals whose electron resonance spectra have been detected.

Radical	Electronic state	Method	Reference
OH	$^2\Pi_{3/2}$	H_2O discharge	7
	$^2\Pi_{1/2}$	H_2O discharge	8
SH	$^2\Pi_{3/2}$	H_2O discharge + H_2S	9, 10
SeH	$^2\Pi_{3/2}$	Se(solid) + H	10
TeH	$^2\Pi_{3/2}$	Te(solid) + H	10
SO	$^3\Sigma$	SO_2 discharge; OCS + O	11, 12
	$^1\Delta$	OCS + O + $^1\Delta$-O_2	13
ClO	$^2\Pi_{3/2}$	Cl_2/O_2 discharge	1, 4
BrO	$^2\Pi_{3/2}$	Br_2 + O	1, 14
IO	$^2\Pi_{3/2}$	CF_3I + O	this work
NS	$^2\Pi_{3/2}$	H_2S + N	1, 15
SF	$^2\Pi_{3/2}$	OCS + F	this work
SeF	$^2\Pi_{3/2}$	OCSe + F	this work
SeO	$^3\Sigma$	OCSe + O	this work
	$^1\Delta$	OCSe + O + $^1\Delta$-O_2	this work

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