BIORESORBABLE FREQUENCY-SELECTIVE MAGNESIUM MICRO-RESONATORS FABRICATED BY ION BEAM ETCHING

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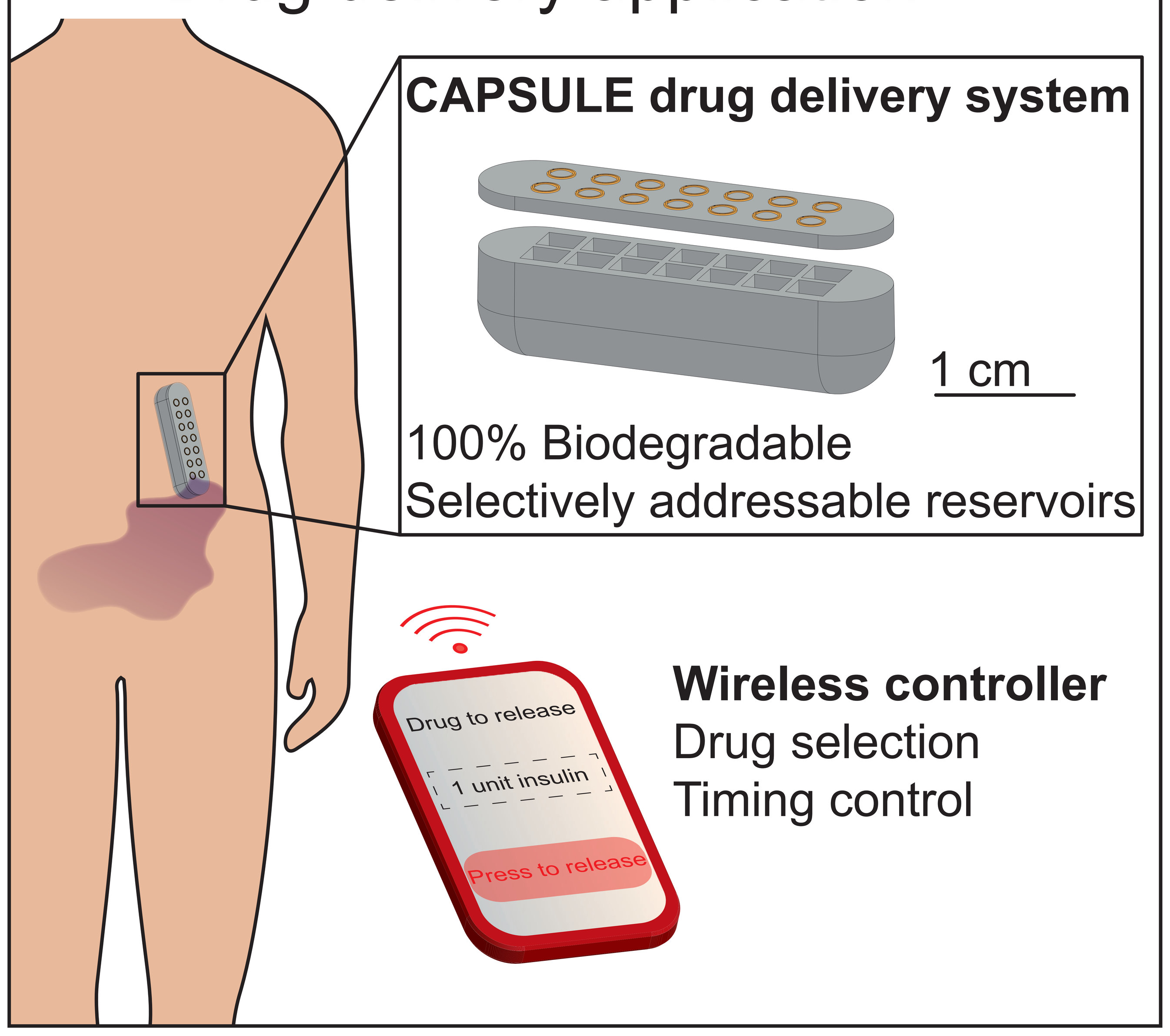
Summary

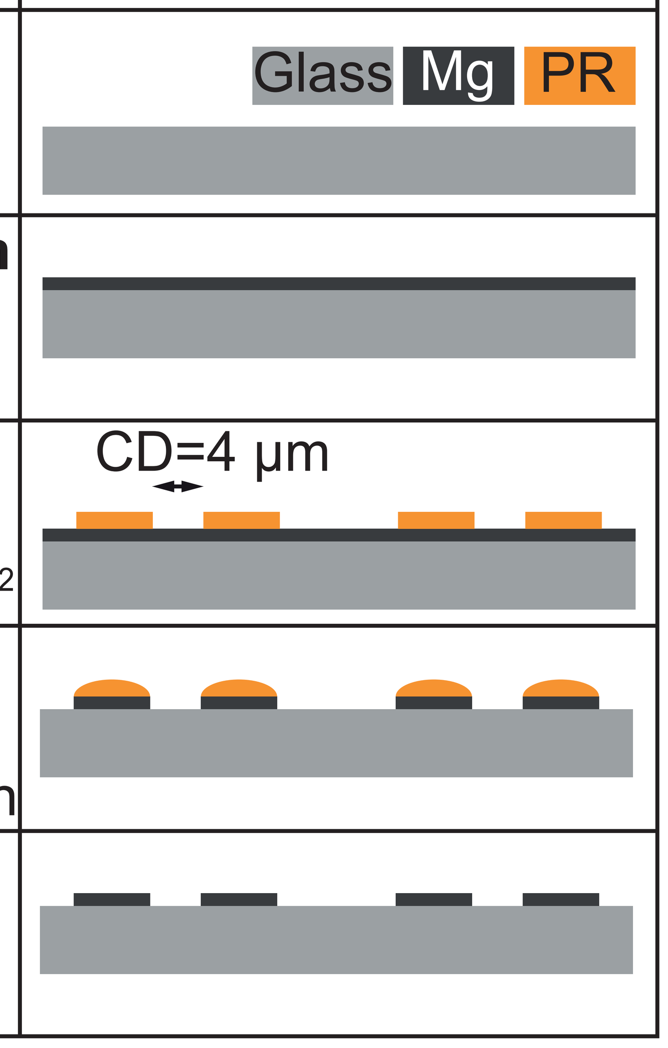
We present an innovative microfabrication process to fabricate magnesium-based bioresorbable microelectromechanical systems (MEMS) by ion beam etching. This process enables the fabrication of thin biodegradable water-soluble passive electronic components with minimal exposure to aqueous media, by a novel physical vapor deposition, photolithography and dry etching sequence. We demonstrate the design, fabrication and characterization of frequency-selective magnesium RF micro-resonators in air and in water, and compare the results to values obtained by finite element modeling (FEM). Such resonators are candidates for selectively-addressable RF power receivers for bioresorbable wireless implantable medical devices.

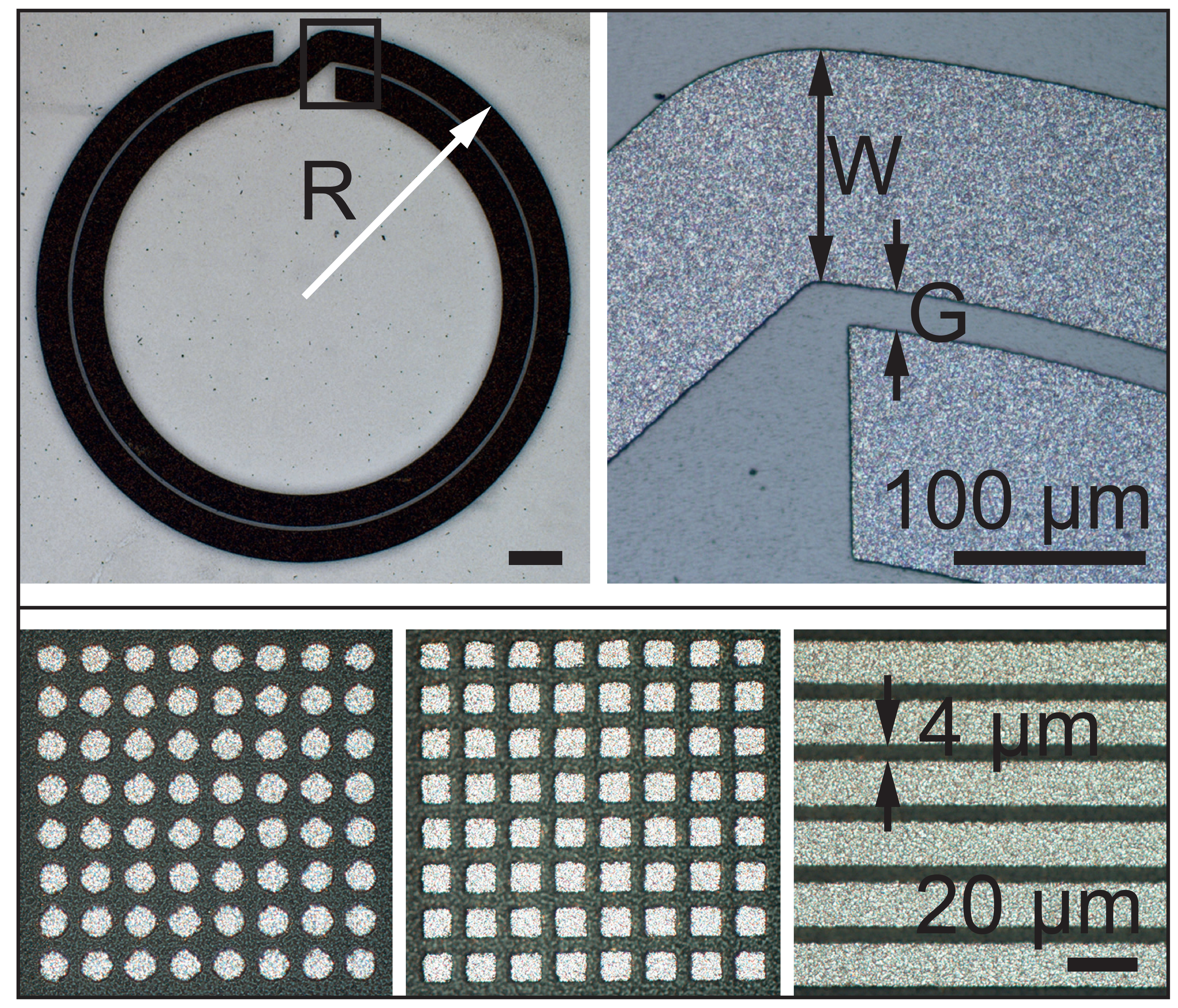
Drug delivery application



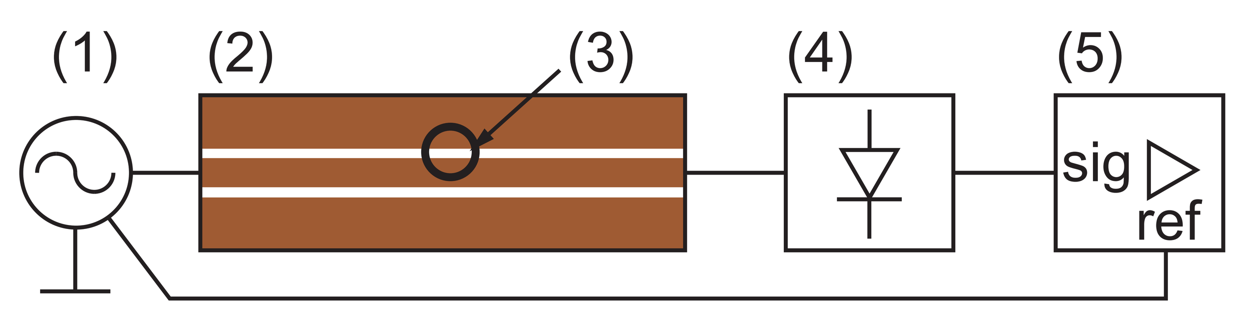
Micro-resonators fabrication

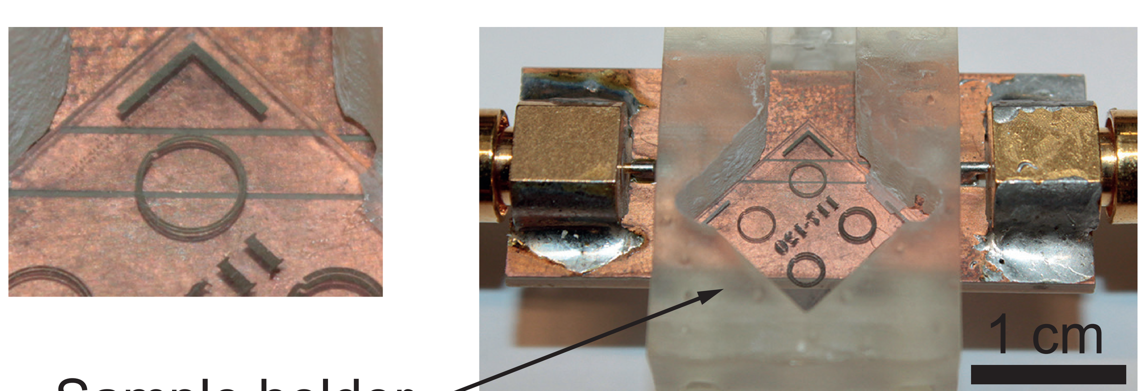
Process description	Cross-section
Substrate: float glass Thickness: 550 µm	
Mg thin film deposition Thickness: 2 µm P=2.2 mbar, R=8 Å/s	
Photolithography 10 min dehyd. at 120°C AZ9260 2 µm, 150 mJ/cm^2	
Reflow + Mg dry etch 2 min reflow at 120°C IBE: -10° tilt, 100 nm/min	
Photoresist strip 1 min O_2 plasma Acetone - IPA - N_2	

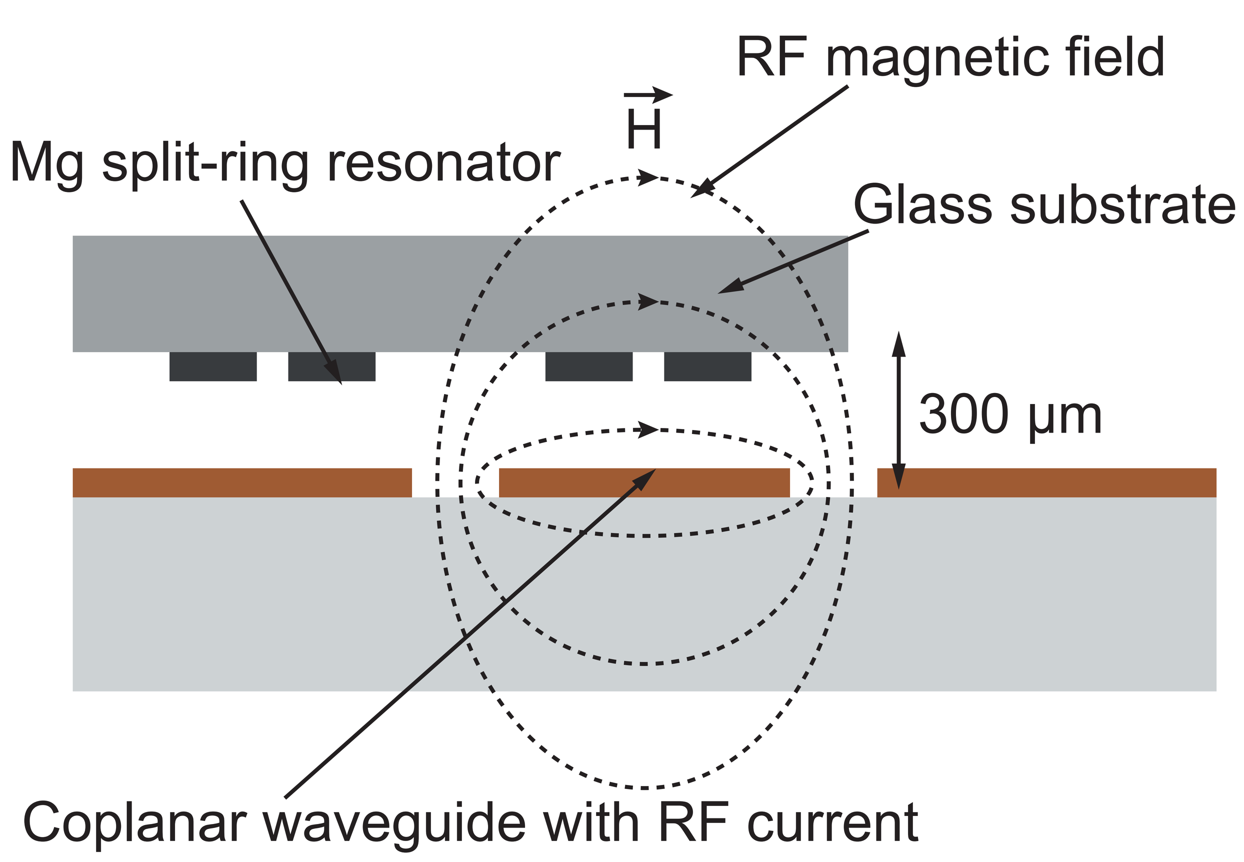




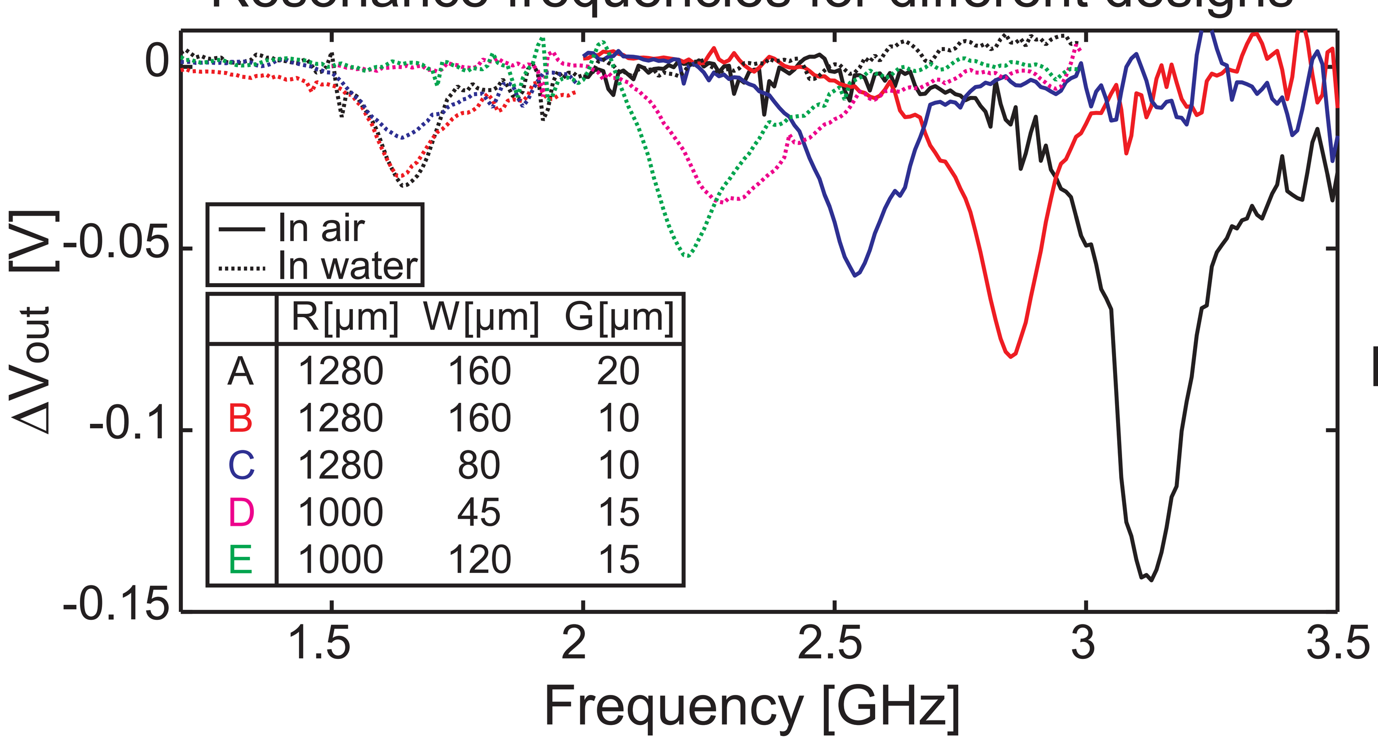
Micro-resonators characterization



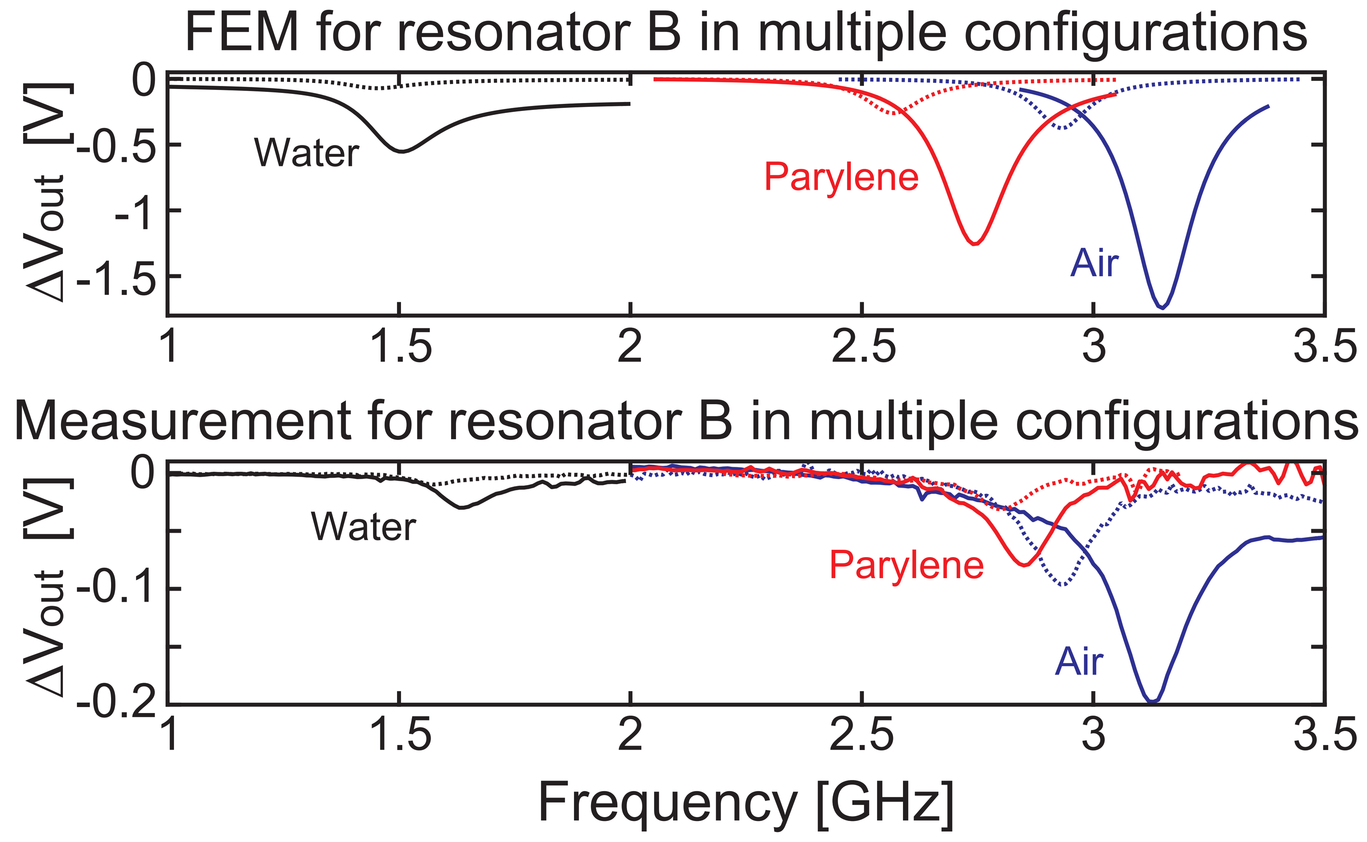




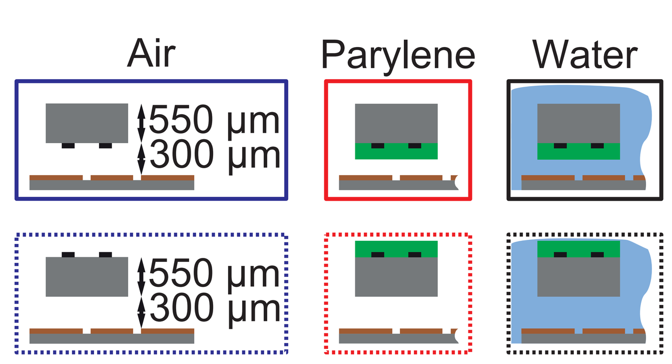
The characterization setup consists of (1) a signal generator, (2) a coplanar waveguide, (3) a resonator, (4) a power detector and (5) a lock-in amplifier.

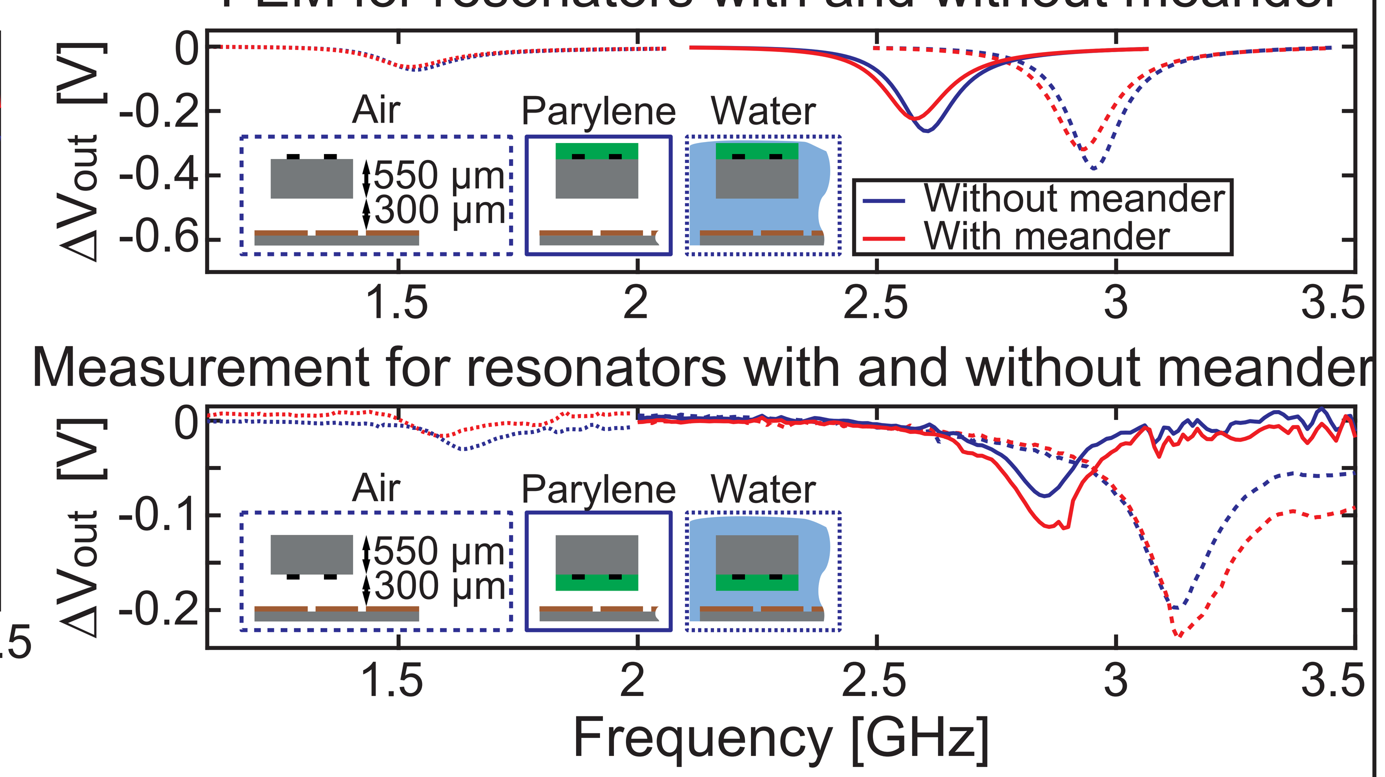


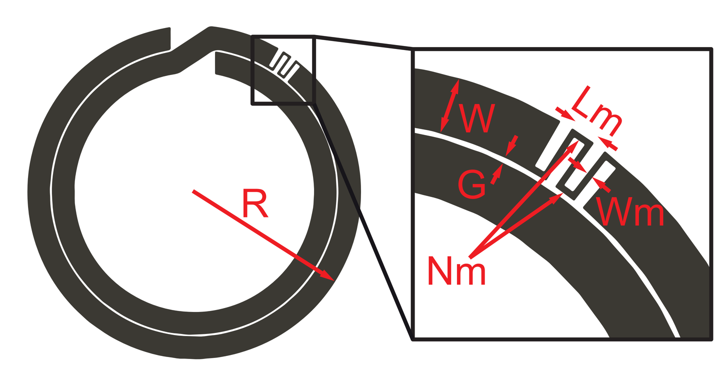
	R[µm]	W[µm]	G[µm]
A	1280	160	20
B	1280	160	10
C	1280	80	10
D	1000	45	15
E	1000	120	15



	FEM		Measurement	
	f_0 [GHz]	Q	f_0 [GHz]	Q
— (blue solid)	3.15	19	3.13	15
··· (blue dotted)	2.93	22	2.93	17
— (red solid)	2.74	16	2.85	18
··· (red dotted)	2.57	17	2.80	19
— (black solid)	1.51	6	1.63	10
··· (black dotted)	1.45	8	1.57	10







	FEM		Measurement	
	f_0 [GHz]	Q	f_0 [GHz]	Q
- - (blue dashed)	2.93	22	3.13	15
- - (red dashed)	2.91	19	3.13	13
— (blue solid)	2.57	17	2.85	18
— (red solid)	2.54	16	2.89	16
··· (blue dotted)	1.45	8	1.63	10
··· (red dotted)	1.44	8	1.59	10

	R[µm]	W[µm]	G[µm]	Wm[µm]	Lm[µm]	Nm[µm]
B	1280	160	10	-	-	-
F	1280	160	10	20	50	1

Results show that different resonator designs resonate at distinct frequencies in air and in water. However, the frequency-shift due to geometrical variations is more important in air than in water. FEM and measurements show a good correlation in multiple configurations. Finally, adding a meander to create a hot-spot in the resonator only decreases the quality factor by 10 to15%, while palcing the resonator in water reduces it by 30 to 50% in comparison to air.

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