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Two-chamber configuration of the Bio-Nano ECRIS

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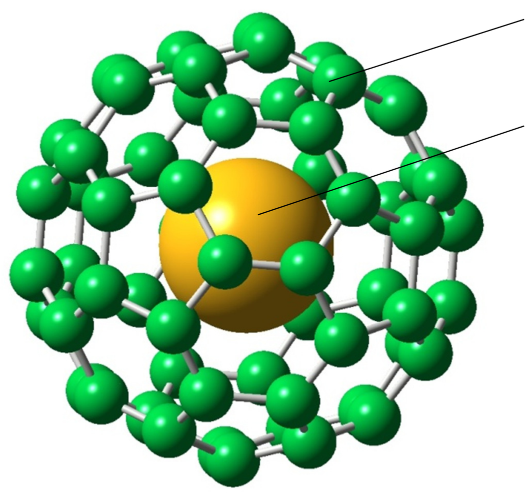
Abstract

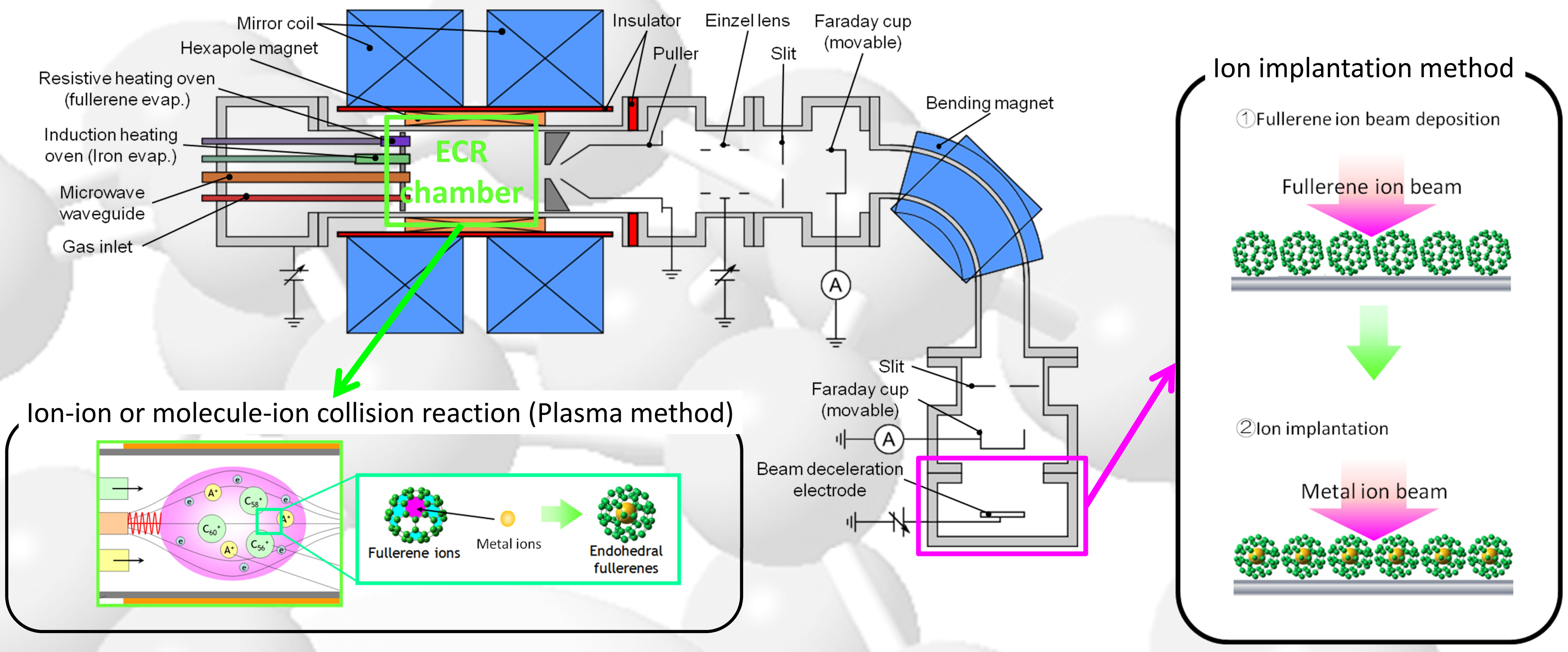
We are studying the application of the electron cyclotron resonance ion source (ECRIS) for the new materials production on nano-scale. Our main target is the endohedral fullerenes. There are several promising approaches to produce the endohedral fullerenes using an ECRIS. One of them is the ion-ion collision reaction of fullerenes and aliens ions to be encapsulated in the mixture plasma of them. Another way is the shooting of ion beam into a pre-prepared fullerene layer. In this study, the new device configuration of the Bio-Nano ECRIS is reported which allows the application of both methods. The basic concept and the preliminary results using Ar gas and fullerene plasmas are described.

1. Our target



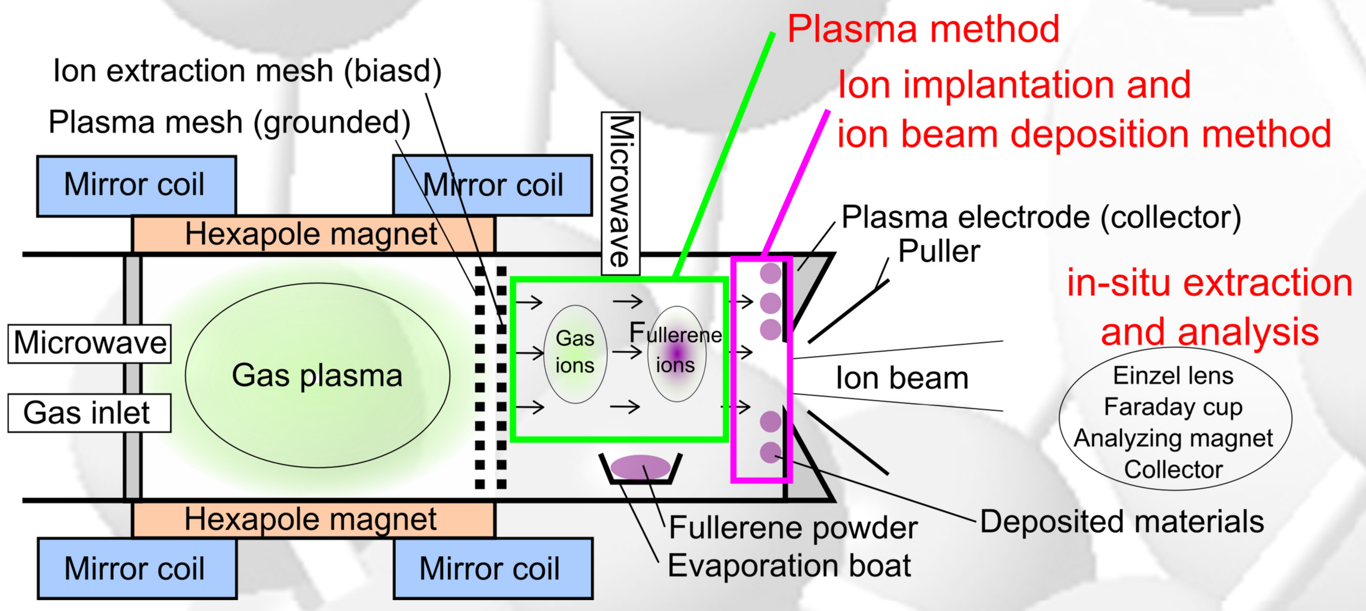
◆Contrast agent for MRI
◆Microwave heat therapy

2. Normal Bio-Nano ECRIS with min-B configuration and possible production method using ECRIS

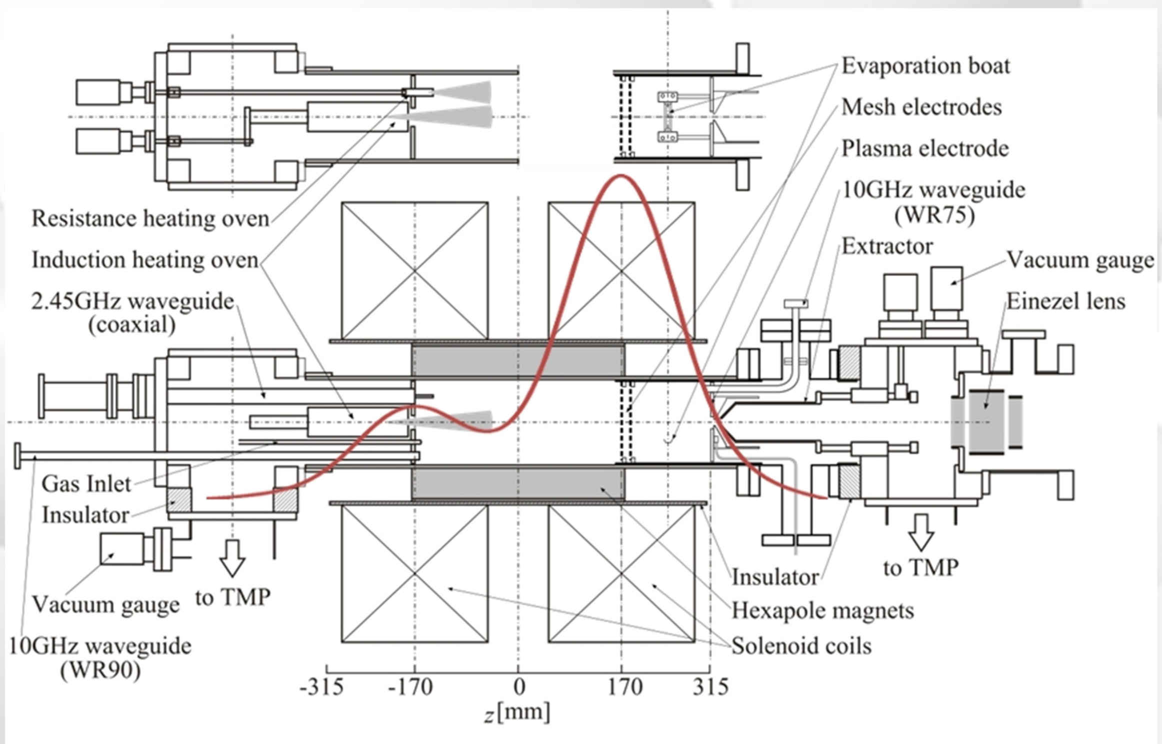


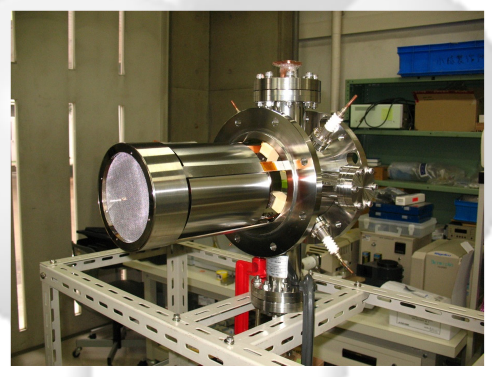
3. Two-chamber configuration of the Bio-Nano ECRIS

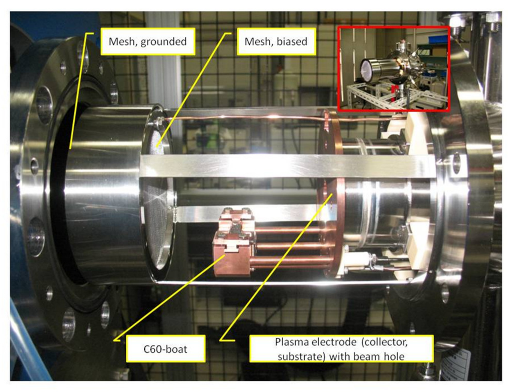
3-1. Concept



3-2. Schematic of the two chamber configuration and photos of the processing chamber

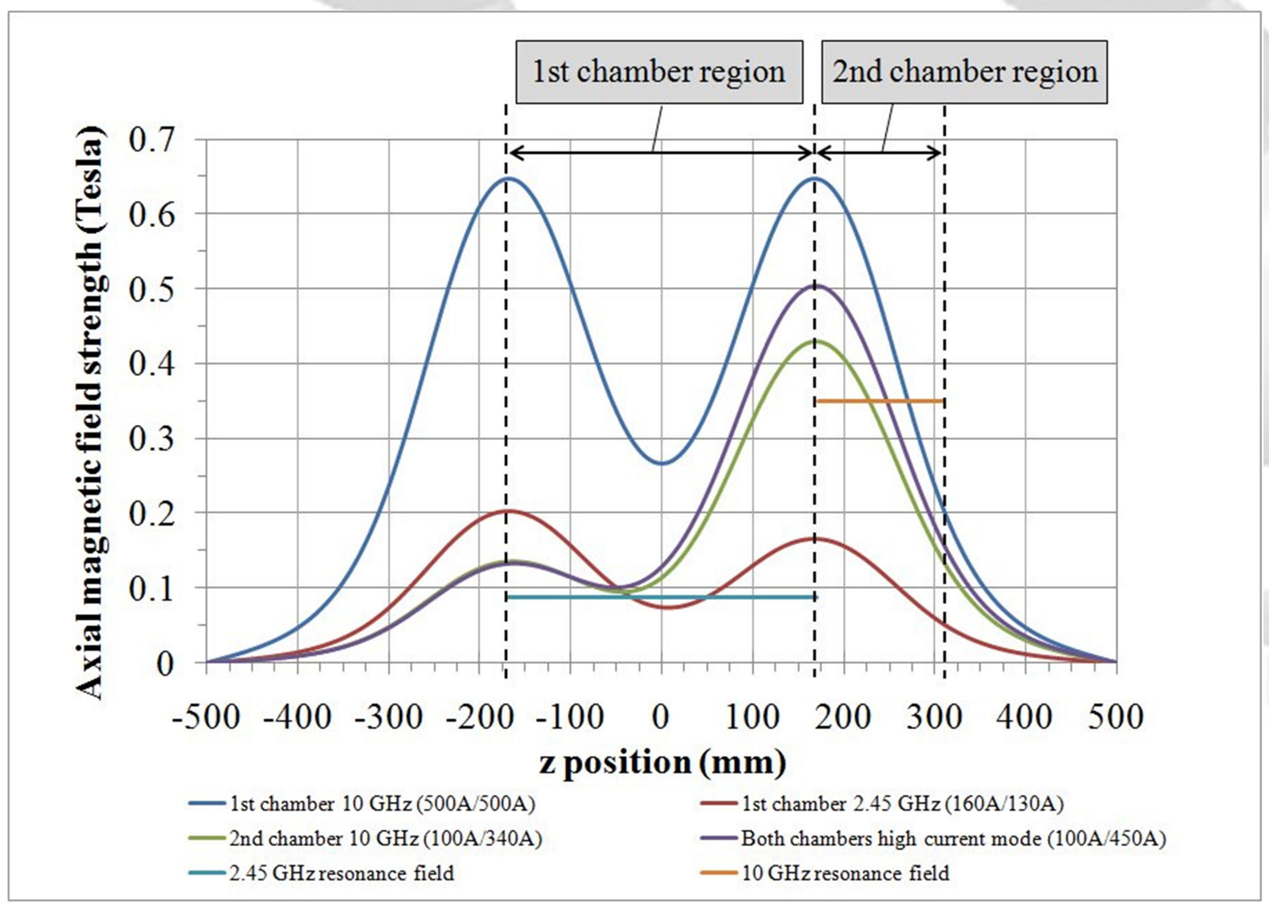






4. Results

4-1. Calculated axial magnetic field strength



4-2. Comparison table for each result

		Plasma in the 1st chamber			Plasma in the 2nd chamber			Plasma in both chambers		
				Opt. for max I_sub			Opt. for max I_sub	Ar plasma in both	1st - Ar, 2nd - C60	Opt. for C60+
year		2008	2010	→	→	→	→	→	→	→
extraction voltage	**kV**	5	→	→	→	→	→	→	→	→
frequency-1	**GHz**	9.75	2.45	→	→	→	→	→	→	→
power-1	**W**	50	40	→	0	→	→	40	→	→
frequency-2	**GHz**	not installed	9.75	→	→	→	→	→	→	→
power-2	**W**	not installed	0	→	50	100	50	→	22 - 40	→
injection magnet current	**A**	500	100	160	100	→	→	→	139	→
extraction magnet current	**A**	500	340	130	340		450	340	340	400
gas		Ar	→	→	→	→	→	→	→	→
gas rate	**sccm**	?	0.297	0.26	0.4	→	→	0.297	0.338	→
Injection-side pressure	**Pa**	8.E-03	6.E-02	→	?	→	→	6.E-02	8.E-02	→
Extraction-side pressure	**Pa**	6.E-04	9.E-04	→	?	→	→	9.E-04	1.E-03	→
mesh voltage	**V**	-2	-1	-4.3	-1	→	→	→	→	→
mesh current	**mA**	-1...+1	-0.6	0	2.6	→	4	-0.35	-0.8	-
substrate voltage	**V**	-40	→	→	→	→	→	→	-20	→
substrate current	**mA**	4	0.27	**0.7**	0.36	-	**19**	0.38	-0.02	-
FC1 current, max	**mcrA**	40	12	-	0.45	0.86	**40**	10.8	0.4	-
FC2 current	**mcrA**	-	3.5 (Ar+), 0.15 (Ar++)	-	-	-	-	-	0.0001 (C60+)	**0.045 (C60+)**
Boat current	**A**								37	→
Boat Voltage	**V**								1.9	→
Remark			TMP1 valve closed							

5. Summary

◆The first and most important result is that the two-chamber configuration ECRIS works in each tested modes.
◆The 1st chamber only operation mode works as traditional B-minimum ECRIS.
◆In the 2nd chamber operation mode only a not-closed ECR-surface exists and both gaseous and C_{60} plasmas and ion beams can be produced.
◆ In the two chambers together mode however the configuration is strongly limited by the requirements for the 2nd chamber. A strongly asymmetrical magnetic field distribution is necessary where the extraction peak is much higher than the injection peak.
◆ The next technical steps in the 2-chamber configuration experiments logically are the testing of other frequencies in the chambers. It can be the application of the same 10 GHz in both chambers or simply the exchange of the present two frequencies.