**Development of an electron cyclotron emission imaging system**

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Fabrication of the electron cyclotron emission imaging system for the Cyclotron Institute's electron cyclotron resonance ion sources (ECRIS) has proceeded over the past year and is nearing completion. This has included mechanical construction and electronics fabrication, but much of the recent work has focused on completing the optical components of the system.

Fabrication processes for both ceramic (Magnesium Aluminate) and plastic (standard-grade PLA) microwave lenses have been developed and put into practice over the past year. The PLA lenses can be directly 3D-printed in ready-to-use sections that are later glued together. 3D-printed PLA master positives and mother molds, parametrically generated in OpenSCAD, are being used to create silicone molds that cast ceramic lens sections from Aremco's Ceramacast 575-N. Simple lenses like the primary lens in Fig. 1 can be molded only using a master positive, but a more complex mold is shown in shown in Fig 2 along with molded lens sections it produced.

FIG. 1. Prototype primary optic lens in non-magnetic fixturing.

Design procedures and codes have been refined to reduce optical aberrations and better match lenses to produce high numerical aperture microwave optical systems. The theoretical development has also included anti-reflection coatings which can be 3D-printed from PLA for both ceramic and PLA lenses.

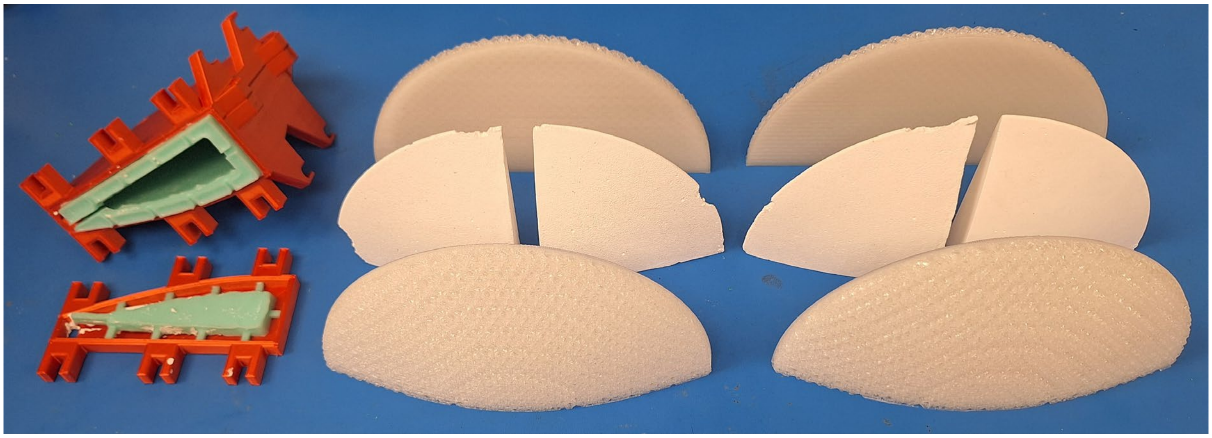

FIG. 1. Silicone mold, cast ceramic lens quarters, and 3D-printed anti-reflection coatings in an unassembled state

Finding a suitable fabrication method for the long alumina waveguides that will transport the image away from the plasma chamber has proven to be a challenge, but there is promise in the current approach to cutting and metallizing the alumina rods and we hope to report success very soon.

In order to supplement available material data, a simple material characterization method using a known-shape prism of an unknown index material was demonstrated and put into use. What the method lacks in precision it makes up for in simplicity and broad frequency applicability, and the precision achieved was found to be sufficient for current purposes anyways. The prism method has also proven useful for quickly validating intuitions about how the refractive index of 3D-printed structures should vary as the infill of the structure is changed. Examples of such prisms are shown in Fig. 3.

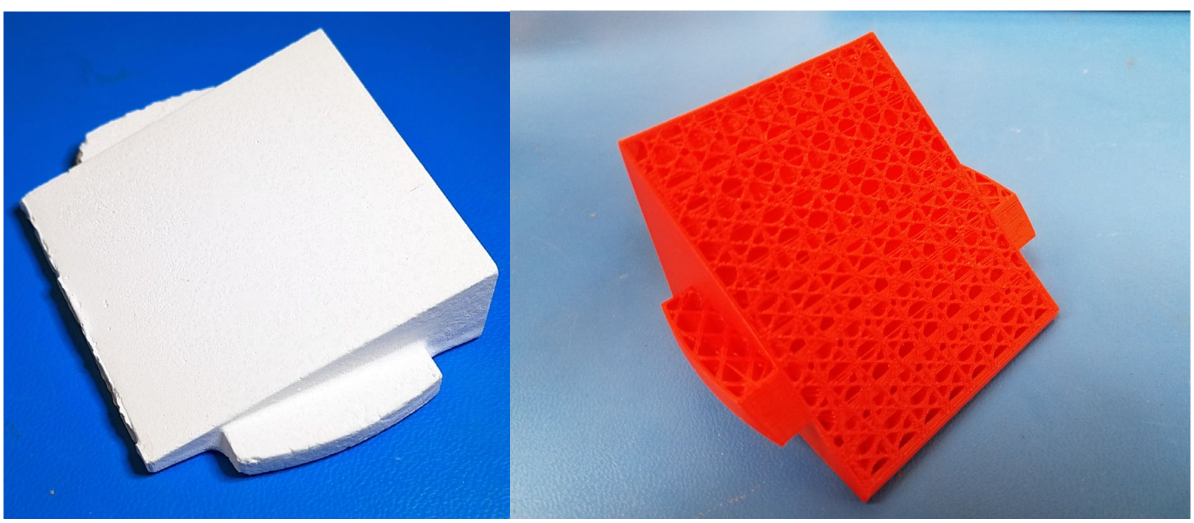

FIG. 3. Examples of prisms used to characterize refractive index for (left) Aremco Ceramacast 575-N and (right) standard-grade PLA with varied infill.