Design of a new Pomeranchuk cell for production of hyperpolarized solid ^{3}He

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From the last year on, we have developed the Pomeranchuk cell to produce the highly polarized solid ^{3}He . Though the ^{3}He NMR spectra were taken for the liquid ^{3}He at T=1.4-0.6 K at 0.04 MPa [1, 2], we failed in observing the NMR spectra for the solid ^{3}He because gas leak of the Pomeranchuk cell occured during the compressing process. It was found that the the gas leakage was mainly caused by insufficient soldering of the interface formed by the phosphor-bronze bellows and the Cu flanges, and poor epoxy (mainly Stycast 2850) seal of loose screws connecting the polycarbonate cylinder and Cu flanges. There were also a lot of leak troubles in epoxy seal for the SUS capilary tubes and in Indium seal. (see Fig. 1.)

After the important lesson of failure we started designing an improved Pomeranchuk cell; a silver welding was employed instead of usual soldering, no stycast was used to sealing of the capilary tubes inserted in the polycarbonate cylinder, and tight screw pitch rates were used for tight connection the polycarbonate cylinder with the metallic parts, and Indium free shielding was employed as shown in Fig. 2.

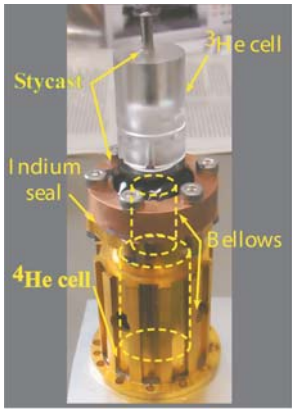

Figure 1: Gas leak of the old Pomeranchuk cell

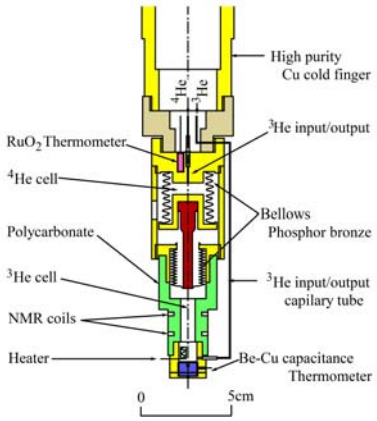

Figure 2: A new Pomeranchuk cell

We discussed recently a practical method to efficiently (in a short time), produce the highly polarized solid ^{3}He by means of the brute force method [3]. Firstly, we must keep the following facts experimentally established in mind;

1. ^{3}He spin polarization of ^{3}He occurs at the liquid-solid interface because of the presence of many vacancies due to the difference in density of both phases,
2. the spin relaxation time of the solid ^{3}He is very long because of the small spin diffusion constant.

This result predicts that one cannot obtain the highly spin polarized solid ^{3}He if one quickly solidifies the liquid ^{3}He by compressing the liquid ^{3}He rapidly. In fact, the favorable solidification rate is required $2\%/h$ for creation of the large spin polarization in case of B=9.2 Tesla and T=3 mK [4]. It is also suggested in ref. [4] to use the A_1 superfluid state of ^{3}He . This will hopefully speed up the creation rate.

References

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