

$$J_1 = A Q_1 Q_2 M Q_2 Q_1 \begin{pmatrix} 1 \\ 0 \end{pmatrix}, \quad J_2 = A Q_2 Q_1 M Q_1 Q_2 \begin{pmatrix} 1 \\ 0 \end{pmatrix}$$

where  $J_1$  and  $J_2$  represent the state of polarization of the light transmitted by the intra-cavity polarizer, A is the Jones matrix for analyzer,  $Q_1$  is the Jones matrix for  $\lambda/4$  plate when its fast axis is oriented at an angle  $45^\circ$ ,  $Q_2$  is the Jones matrices for Pockels cell with  $\lambda/4$  voltage and kept at angle  $\theta$ , M is the Jones matrix for the mirror for normal incidence, and  $\begin{pmatrix} 1 \\ 0 \end{pmatrix}$  represents the polarized light. Plot of  $J_2$  and  $J_1$  are shown in Fig.L.11.3 and Fig.L.11.4 respectively.

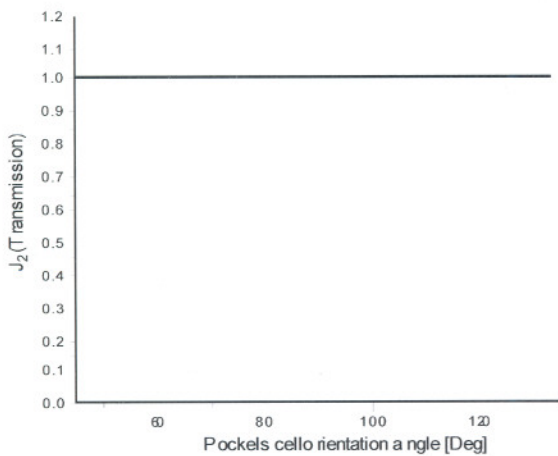


Fig. L.11.3: Theoretically calculated transmission of the intra-cavity polarizer ( $J_2$ ) versus the orientation of Pockels cell.

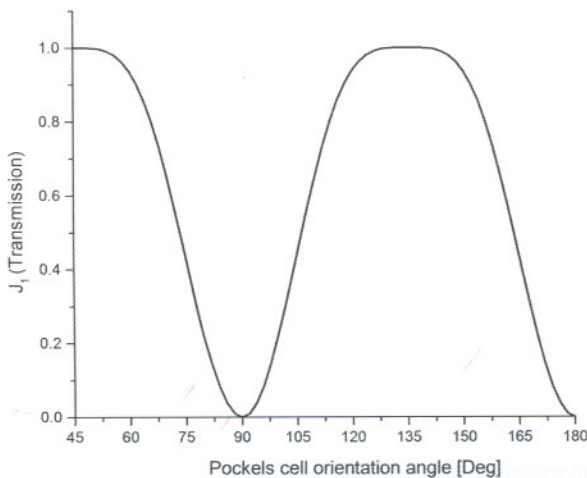


Fig L.11.4: Theoretically calculated transmission of the intra-cavity polarizer ( $J_1$ ) versus the orientation of Pockels cell

From Fig.L.11.3 it is clear that low cavity Q can be maintained irrespective of orientation of the Pockels cell,

whereas this is not true in Fig. L.11.4. As a result of this, the rotation of the plane of polarization is observed in the output when compared to the plane of polarization of intra cavity polarizer.

It is also observed that when the  $\lambda/4$  plate and the cell are interchanged in Fig.L.11.3, one can maintain high cavity Q, irrespective of the orientation of Pockels cell. However, the plane of the polarization of the output is rotated depending on Pockels cells orientation. Here one can generate orthogonal polarization with maximum output energy, when the Pockels cell is kept at  $45^\circ$  or  $135^\circ$

Figure L.11.2 shows that the cavity Q depends on Pockels cell orientation. Here, the output energy is a function of the orientation angle and it varies from zero to maximum. However the output polarization is linear and insensitive to orientation. It is found that interchanging the cell and  $\lambda/4$  plate in Fig.L.11.4 gives an ideal configuration in which the cavity Q, the output energy, and the polarization are insensitive to the orientation of the Pockels cell. [For more details, please see : R. Sundar et al, to appear in *Optics and Laser Technology*, 2009.]

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## L.12 Development of platinum-loaded carbon aerogel catalyst for isotopic exchange of hydrogen and deuterium

Carbon aerogels, due to their large surface area, high porosity, and low density, are finding increasing use for a variety of applications like ultrahigh value capacitors, fuel cells, and catalysts. Target Laboratory, RRCAT, has over the years successfully developed the technology for the synthesis of these materials. Both, aqueous route (water-ethanol-liquid  $CO_2$ ), and surfactant based open air drying method, have been developed for this purpose. Further, various scaffolding techniques have been developed and utilised to prepare carbon aerogels of different morphologies (thin large sheets of up to 200 mm x 150 mm; cylinders of up to 100 mm length and 30 mm diameter and Rasching rings of size 8 mm x 10 mm). The SEM image (Fig.L.12.1a) of carbon aerogel synthesised by the surfactant based method shows the high porosity and interconnected open pore structure of the material. The pore volume and surface area of the aerogel were measured to be 1.4  $cm^3/g$  and 550  $m^2/g$ . The pore size ranged from 10 nm to 30 nm.

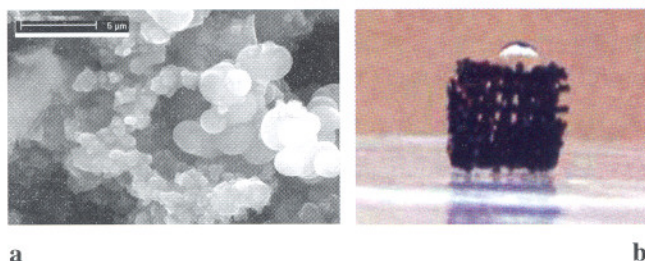


Fig. L.12.1: a) SEM image of carbon aerogel; b) A Pt loaded carbon aerogel coated Dixon ring with the desired hydrophobic characteristics.

Platinum loaded carbon aerogels of different morphologies have also been developed and investigated for their use as catalyst in liquid phase catalytic exchange process that can be used for the production of heavy water. Preliminary experiments (both static and dynamic) carried out at Heavy Water Plant, Vadodara, have provided very encouraging results and demonstrated the potential of these catalysts as a promising approach for the production of heavy water. Heavy Water Board (HWB), Mumbai has therefore signed a *Memorandum of Understanding* with RRCAT for the further development of these catalysts with the goal of realising industrially suitable wet proof catalyst.

Realization of an industrially suitable carbon aerogel based catalyst requires development of means of improving the mechanical strength of the catalyst and simultaneously ensuring its hydrophobicity. The strategy adopted for this purpose was to coat stainless steel Dixon rings with Pt loaded carbon aerogels as it would provide the desired mechanical strength, high surface area and Pt economy, since a thin layer of the catalyst would be sufficient. The challenge of achieving good adhesion of carbon aerogel coating on the surface of Dixon rings was successfully met after experimenting with different pre-treatments of the Dixon ring surface. Use of polyvinyl difluoride solution and aqueous colloidal suspension of poly tetra fluoro-ethylene as binders provided the desired hydrophobicity. Careful optimization of the ratio of binder to carbon aerogels powder and other process parameters helped achieve uniform coating (Fig L.12.1b). A large number (~ 4000) of coated Dixon rings of 8 mm x 8 mm size were produced with manpower resource provided by HWB. The isotopic exchange capacity of the Dixon ring based catalyst has been measured at HWP, Vadodara using the experimental arrangement (shown in Fig L.12.2) developed at RRCAT.

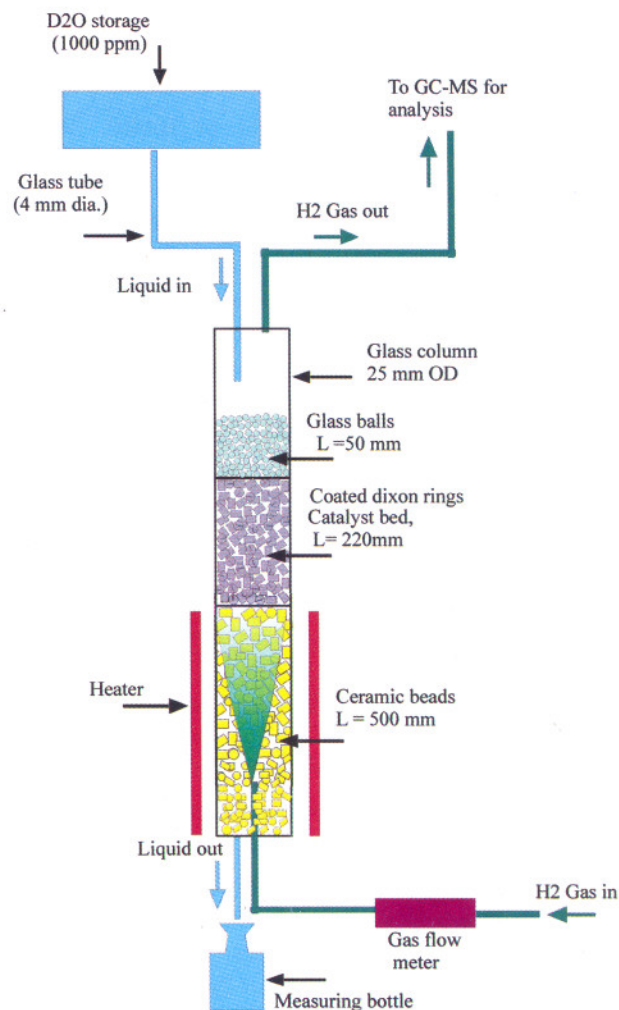


Fig. L.12.2: Sketch of the experimental setup used for testing catalyst

With the optimization of various operating parameters (gas and liquid flow, temperature and humidification of the hydrogen gas), enrichment of deuterium in hydrogen gas from an initial concentration of 48 ppm to 71 ppm was obtained. This corresponds to a  $Ky.a$  value of  $0.67 \text{ m}^3 \text{ (STP).s}^{-1}.\text{m}^{-3}$ , which compares favourably with the best values reported in the literature.

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