MLF Experimental Report	提出日 Date of Report
課題番号 Project No. 2014A0330 実験課題名 Title of experiment Structure analysis for amorphous carbon with low friction by total scattering measurement 実験責任者名 Name of principal investigator Hiroshi NOZAKI 所属 Affiliation Toyota Central R&D Labs., Inc.	装置責任者 Name of responsible person Toshiya Otomo 装置名 Name of Instrument/（BL No.） NOVA/BL21 実施日 Date of Experiment 2014/6/13-13, 11/20-21

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

DLC1: CD_a, DLC2: CD_b, DLC3: CD_c, DLC4: CD_d (a,b,c,d = 0.1 ~ 0.4), DLC5: synthetic graphite (C).

2. 実験方法及び結果（実験がうまくいかなかった場合、その理由を記述してください。）
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

1. Experimental

The samples of amorphous carbon (CD_x: DLC) were synthesized on an iron plate by a plasma chemical vapor deposition (CVD) method using CD_4 gas as a precursor. We used CD_4 gas instead of CH_4 gas because hydrogen produces a large background in a neutron scattering spectrum. Then, the powder sample was collected by scratching the deposited DLC [1]. We produced four DLC samples with different C/D ratio and synthetic graphite as a reference sample. The powder samples were filled into a vanadium container in air. The neutron scattering spectra $S(Q)$ was measured on NOVA spectrometer at room temperature for several hours. Then, the radial distribution function (RDF) spectra were obtained by a Fourier transform.

2. 実験方法及び結果（つづき） Experimental method and results (continued)

The RDF spectra are shown in Fig. 1. There are clear several peaks (r_n; i=1-7) corresponding to the C-C, C-D, or D-D bonds at r < 5Å region for each sample. Because the peak position of r_2 (=1.41 Å), r_4 (=2.44 Å), r_5 (=2.88 Å), r_6 (=3.69 Å), r_7 (=4.25 Å) for DLC are same as synthetic graphite, those peaks are thought to be derived from C-C bond. From the structural analysis, r_2, r_4, and r_5 correspond to the nearest-neighboring (NN) C-C bond, the next NN C-C bond, the third NN C-C bond within the *ab*-plane, respectively. r_6, and r_7 correspond to the shortest and the second shortest C-C distance between the inter-layer of graphene, respectively. On the other hand, r_1 (=1.1 Å) and r_3 (=2.1 Å) corresponds to the direct C-D bond and the C-D distance between the D atom of C-D bond and the C atom adjacent C-D bond (see Fig. 2). From the peak intensity of r_1, the amount of D atom for each sample is considered to be the following order; DLC3 ~ DLC4 < DLC1 < DLC2. Here, because the statistics for DLC4 sample are relatively low due to the less amount of powder, the amount of DLC4 may be less than DLC1. This is probably connected to the cluster size; that is, the larger the size of cluster is, the less the D/C ratio is.

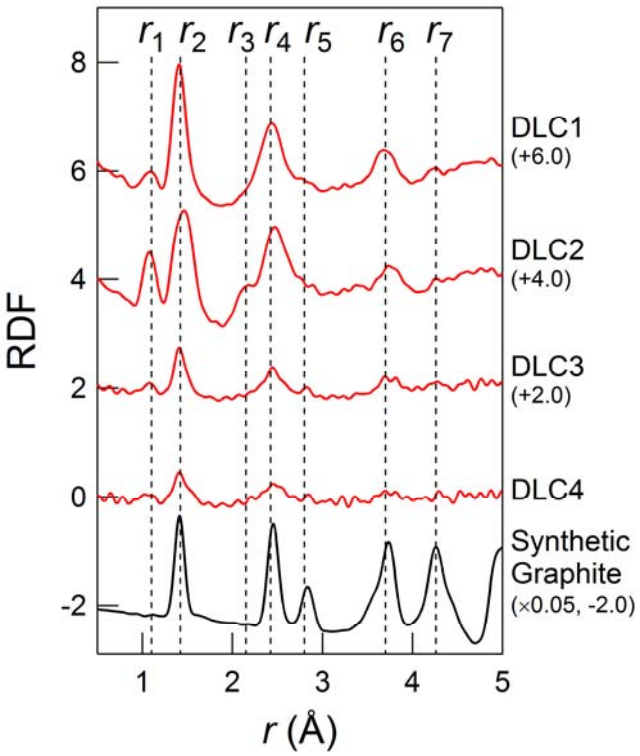

Fig.1 RDF spectra for four DLC samples and reference. Each spectra shifted vertically for the clarity.

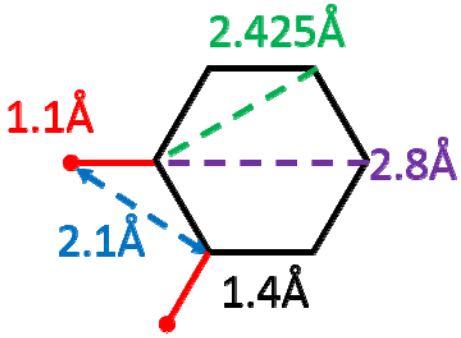

Fig.2 The planer structure of graphene. Black and red solid-line show C-C bond and C-D bond, respectively.

[references]
[1] T. Iseki, et al., Diamond and Related Materials **15**, 1004 (2006).