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Assessing Antibody Microarray for Space Missions: Effect of Long-term Storage, Gamma radiation and High Energy proton radiation

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Abstract

Fluorescent antibody microarray has been proposed for Molecular biomarker detector in planetary exploration [1]. A number of different environmental stresses may affect the antibody performance, such as temperatures variations, highly penetrating radiation and high energy particles. Here we have tested the effect of gamma radiation, proton radiation and long-term storage on the microarray immunoassay and fluorocromes. Although different antibodies might have different susceptibilities we conclude that there was not significant reduction in the functionality of antibodies printed on the microarray and the fluorescent tracers antibodies, even in a extreme case of receiving a radiation dose 3000-fold than a biochip would receive in a trip mission to Mars. In summary, antibodies are suitable for use in planetary exploration purposes.

1. Introduction

Microarray technology allows for the covalent binding from tens to thousands of probes in a few square centimeters [2], [3]. Antibodies are robust molecules when they are correctly stored: low temperature and dryness, usually, is the correct way in normal conditions. Antibodies have been proposed in recent years as sensor for the detection of biomarkers in astrobiology. An instrument called SOLID [4] “Signs of life detector” was developed in our institute for in situ analysis by using an antibody microarray, the so-called LDChip300 [5], which has been successfully tested in different field campaigns.

The aim of this work is to test the effects radiation on the microarray assay and long-term storage. The study was performed by fluorescent sandwich-type microarray immunoassay with the printed (capturing)

antibody microarrays and with fluorescent antibodies (tracers) at the working concentrations. All tested antibodies are relevant components of the LDCHIP immunosensor and have been use in SOLID [4]

2. Method

The antibodies under study are used to detect organic molecules in a sandwich immunoassay (SMI). In a typical sandwich microarray immunoassay, the sample is first incubated with the antibody microarray for one hour, washed with incubation buffer to remove the non-bound material, incubated for one hour with fluorescently labeled tracer antibodies, and then washed again to remove the excess tracer. Finally, the slides are dried out and scanned for fluorescence.

To use this method in planetary exploration, the stability of the antibodies and fluorocromes must be assessed under different space conditions. We subjected the antibodies to different doses of gamma and proton radiation in different facilities, and stored them at different temperatures.

2.1 Gamma radiation of capture antibodies

Capturing antibodies were irradiated with a source of ^{60}Co at the Unidad Náyade of CIEMAT (Spain). Doses of 3, 15 and 150 krad were used. Afterwards, they were stored at -20ºC, 4ºC, room temperature (RT: 23-25ªC) and 50ºC for several periods of time, to study the combined effect of dose radiation, storage temperature and storage period.

2.2 Gamma radiation of tracer antibodies

Tracer antibodies were also irradiated in CIEMAT (Spain), with doses of 3 and 15 krad. They were stored at 4ºC, 25ªC, and under cycled temperature shifts (-20ºC → 25ºC → 50ºC). Sandwich immunoassays were performed 3, 9 and 48 months after the irradiation [6].

2.3 Proton radiation of capturing antibodies

A third set of assays was done by irradiating capture antibodies with a proton beam in the Svedberg Laboratory (TSL) in Uppsala (Sweden). The average proton energy was 156 MeV. The doses were 0.6 krad, 3 krad and 15 krad. The antibodies were stored at -20ºC, 4ºC, room temperature (RT: 23-25ªC) and 50ºC for several periods of time: 0, 30 and 120 days. A fourth assay after a period of 180 days is still pending.

3. Results

We assayed the antibody functionality in each of the irradiated samples by SMI with several antibodies, and the results were compared to parallel assays with non-irradiated samples.

For the cases of gamma irradiated antibodies, both capturing and tracer, the results were quite similar. After 9 months we detected no significant differences between irradiated and non-irradiated slides.

Similarly, even though the assay is not jet complete, preliminary results suggest that the proton radiation at our working doses does not affect significantly our immunoassay.

4. Summary and Conclusions

All the results obtained in the stability tests indicate that our immunoassay with the antibody microarray is very robust against the high doses of gamma and high energy protons, as well as different temperatures, under which it might be subjected in a mission to Mars.

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