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Study of reactor structural materials at the neutron imaging beam line Dhruva, India

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Reactor sources are best suited for advanced imaging techniques such as tomography and phase contrast imaging applications because they have large and stable thermal neutron flux. A neutron imaging beamline has been designed and developed at HS-3018 port of Dhruva reactor (100MW research reactor) and is currently being used for thermal neutron tomography and phase contrast imaging applications. This paper discusses about the experiments which have been done till date on this facility. A brief overview of the beamline design is also provided. The collimator has been designed in such a way that tomography or phase contrast imaging studies can be performed on the same beamline. A sapphire crystal as neutron filter followed by a bismuth crystal for gamma filtering has been used at the input of the collimator to maximize the neutron-to-gamma ratio. The maximum beam size of neutrons has been restricted to ~ 140 mm diameter at the sample position. A cadmium ratio of ~ 250 with L/D ratio of 160 and thermal neutron flux of $4x10^7 n/cm^2/s$ at the sample position has been measured.
Study of hydrogen in reactor materials is particularly important to prevent the hydride induced embrittlement. In many cases, what we need information within bulk of material. Neutrons play a major role as they can penetrate through dense materials with added benefit that one can analyze the sample non- destructively. We have studied hydrogen ingression in reactor clad materials and also quantified the amount of hydrogen present. Neutron tomography studies on blisters in Zr-alloy have been carried out as an aid to NDT. In addition to conventional tomography neutron phase imaging technique are also being explored for those samples which have low neutron absorption cross-section.

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