L.4: Development of metrology system for end plugs for FBTR fuel pins

A machine vision based system, using shadow graph technique, is developed for precision dimension measurement of top and bottom end plugs for Fast Breeder Test Reactor (FBTR) fuel pins. It is mandatary to visually inspect top and bottom plug for each FBTR fuel pin and measure various dimensions to ensure quality before they are used for assembly of FBTR fuel pins.

The machine vision based systems score over human based inspection where large numbers of similar components have to be inspected with high accuracy and speed, as machine vision based systems are independent of factors like monotony and fatigue.

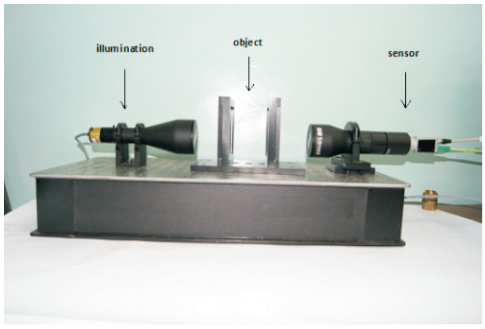

Fig. L.4.1: Photograph of top and bottom end plug metrology setup for FBTR fuel pins

The shadow graph technique relies on producing a shadow of the object by using a collimated back illumination source (Fig. L.4.2). The collimated illumination is obtained by employing a telecentric lens and LED illumination source. The imaging system is based on high resolution digital camera along with bi-telecentric lens to get a high quality, high contrast shadow image. The pairing of collimated illumination and telecentric optics helps in defining sharp edges of the shadow image. The image processing software computes precise measurement of eleven different dimensions of the 'top plug' and seventeen dimensions for the 'bottom plug' with an accuracy of ±10μm.

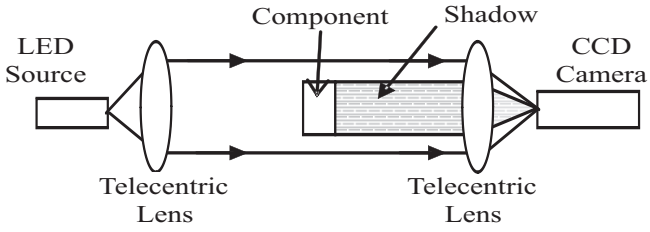

Fig. L.4.2: Block diagram of metrology system utilizing shadow graph technique

A special sample (end plug) holder fixture is designed by ED&D, BARC to hold the sample during measurement. The operator needs to mount the sample under test in this fixture and various dimensions of the sample are computed and displayed on the front panel of the computer screen (Fig. 3) within one second duration. The inspection software generates a detailed report of measurements in MS-EXCEL format. This greatly facilitates documentation for various purposes like, estimating quality of products from batch to batch, classification of faults, control of fabrication processes etc.

This system is installed and commissioned at Radio Metallurgy Division (RMD), NFG, BARC. It is being used by RMD for quality assurance of FBTR fuel end plugs. The user has reported that the metrology system developed at RRCAT, completes the entire measurement cycle in around one second time whereas a trained human inspector can do only few of the above measurements and still requires more than 30 seconds time.

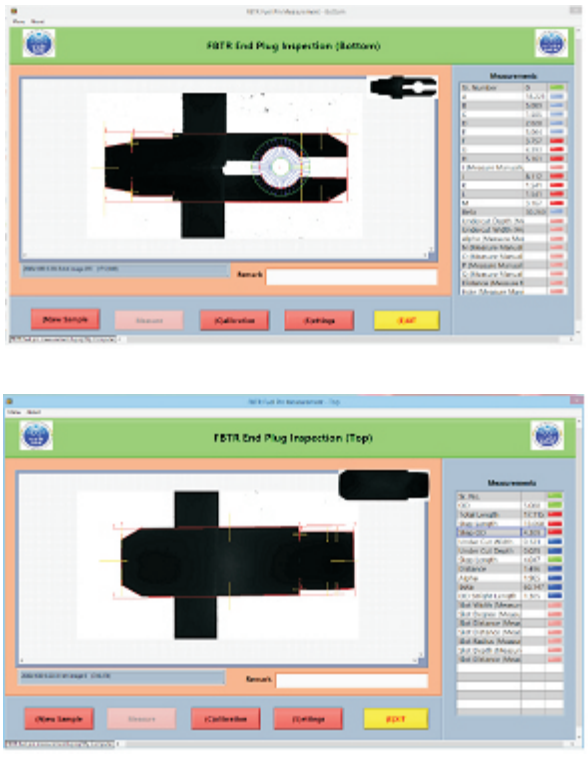

Fig. L.4.3: Screen shot of Inspection software for FBTR metrology system displaying shadow graph image.

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