Room temperature metal bonding in atmospheric air

Expectations for reduction of apparatus cost and improvement of manufacturing efficiency

We have developed a new process for replicating a surface shape of an atomically smooth master substrate onto electroplated Au patterns by a lift-off process using a thin sacrificial layer. In this process, a Ti sacrificial layer and a thin Au seed layer were first deposited on the master substrate. Sealing ring patterns were then formed using a combination of photolithography and Au electroplating. These patterns were next bonded to a Au thin film on a Si wafer. Finally, by chemically dissolving the Ti sacrificial layer, the patterns were released from the master substrate and transferred to the Si wafer. The resulting patterns had an atomically smooth surface with a root-mean-square surface roughness of 0.8 nm. These smooth patterns were bonded to another Au-coated Si wafer at room temperature in atmospheric air. Tensile tests were carried out and a high bonding strength of about 250 MPa was confirmed, with fracture eventually occurring within the Si substrate.

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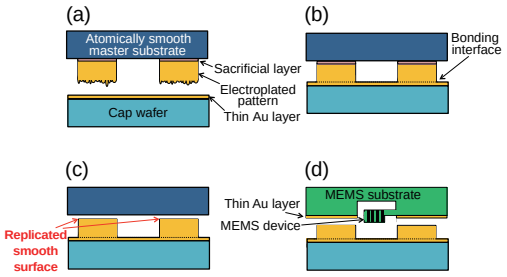
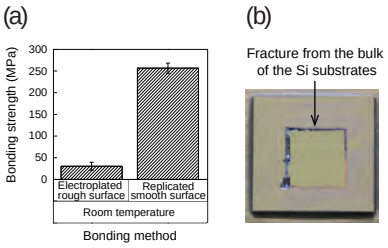


Developed bonding process



(a) Bonding strength
(b) Bonding interface of the sample bonded by using replicated smooth surface

Compact, lightweight pulsed X-ray source for non-destructive inspection

Obtaining X-ray images in narrow places such as parallel pipes in a chemical plant

We have developed a compact (width = 155 mm, height = 160 mm, depth (X-ray outgoing direction) = 70 mm), lightweight (2.5 kg), portable high-energy X-ray source using a coniferous carbon nano-structure (CCNS) electron source for non-destructive inspection. There are several advantages of CCNS for portable X-ray sources including no warm up time and low standby power consumption. Our pulsed X-ray source can operate using USB5V or AA-sized batteries as its power source, with a maximum tube voltage of about 150 kV, maximum tube current of 20 mA and an exposure time of 1 ~ 100 ms. The source can generate 10,000,000 X-ray pulses at an input power of 15 mWh/pulse. We can obtain X-ray images in narrow places such as pipes in a chemical plant. In the future, we will develop a higher-voltage (200 kV) X-ray source and an automatic inspection system using a robot for efficient non-destructive inspection.

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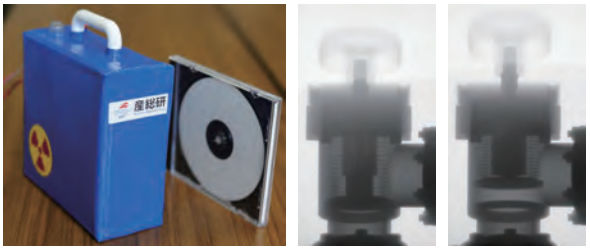
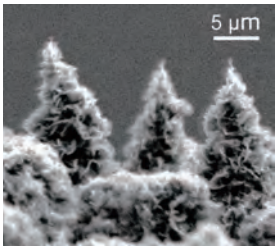


Picture (left figure) of the pulsed X-ray source compared with a CD case, and X-ray images (middle and right figures) of metallic valve at close and open positions



SEM image of CCNSs