CHOTs: Cheap Optical Transducers

Published date: Nov. 18, 2011

Technology description

A new low cost, non-contact method for ultrasonic NDT

Summary

Dr Matt Clark at the University of Nottingham has developed a new approach to ultrasound-based non-destructive testing (NDT) which has many advantages over currently available systems; most importantly it allows remote operation for the first time, but is also inexpensive, small and easy to use. The approach developed relies on a new type of optical transducer, known as a CHOT (Cheap Optical Transducer), and replaces the piezoelectric transducer typically used in ultrasonic testing. CHOTs are structures attached to the surface of the test component that are optically excited using a simple laser set-up to either generate or detect ultrasound.

CHOTs technology is a disruptive technology that will revolutionise the way NDT is undertaken. A portable device to excite the CHOTs and process the ultrasonic signal is underway.

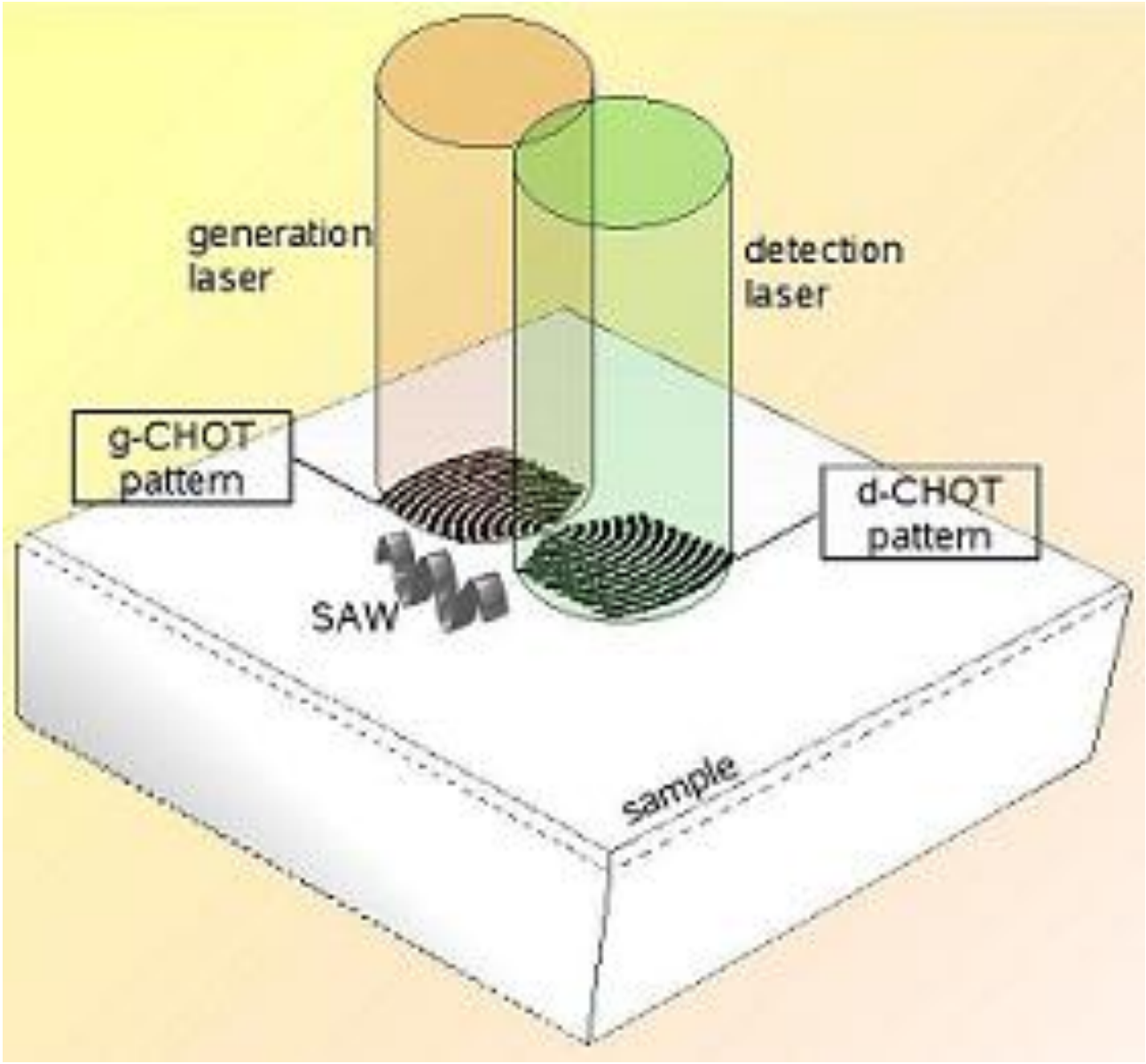

Fig.1 Schematic of CHOTs technology

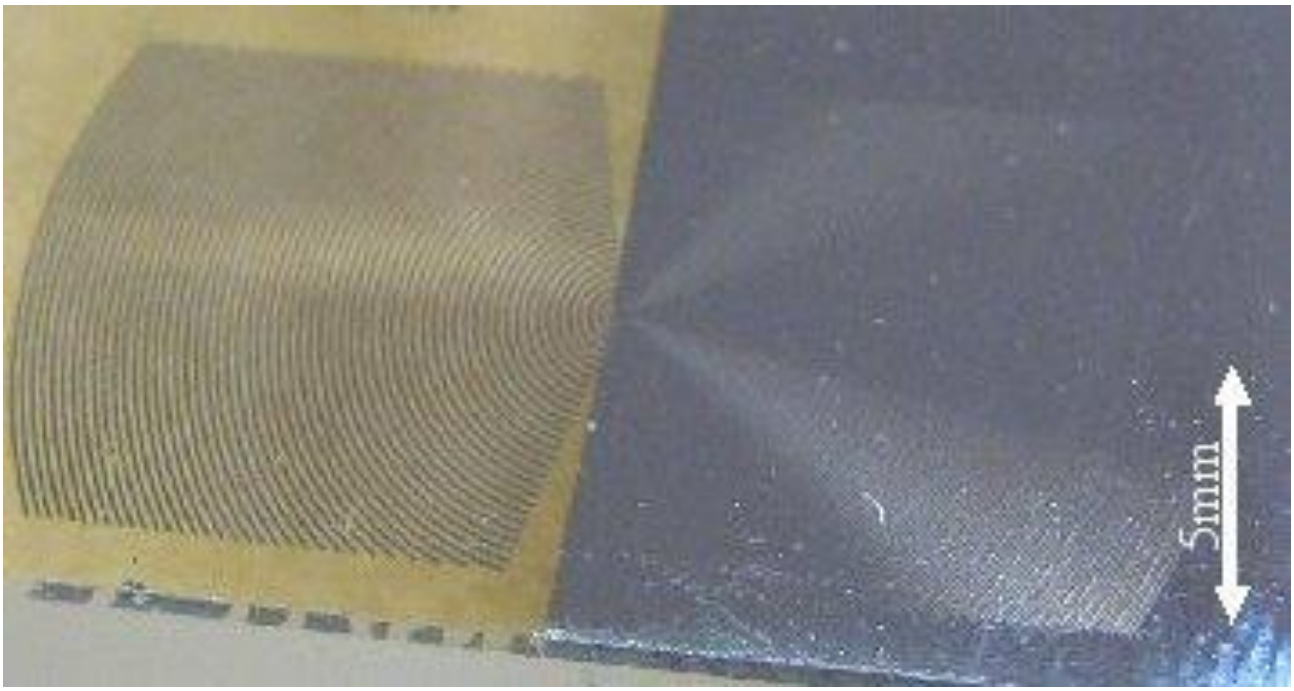

Fig. 2A complete CHOTs transducer system on a sample - the CHOTs devices each measure 10 x 10 mm x 100nm high and are estimated to weigh billionths of a gram.

Markets Sectors

In the first instance, the CHOTs technology is envisaged for sectors that are safety critical and where quality control is a priority:

·Transportation: aerospace (during manufacture but also on equipment in use), rail (train and tracks), automotive;

·Defence: aircraft, ships, tank equipment;

·Chemical and petrochemical plants (e.g. checking pipes and vessels);

·Nuclear and thermal power plants;

·Pharmaceutical and food industry (quality control).

Technical Information

Using ultrasound for the testing of materials is a powerful, well-established and relatively simple technique: ultrasound propagates into the inner structure or surface of the test component and its detection provides information about its properties, thickness, possible defects etc.

Conventional, commercially available, ultrasound systems require expensive piezoelectric transducers which must be placed in contact with the material to be tested (test component), limiting their use in production line environments and ruling out their use for the constant monitoring of systems. Good contact between the transducer and test component is also required, ruling out the testing of components with unusual shapes, including curved surfaces. Alternative, optical ultrasound systems for non-contact operation do exist but are expensive, technically complicated and too bulky to be carried in the field, requiring experienced users and having conditions for operation which can only be found in the lab. These drawbacks have all restrained the commercial exploitation of optical ultrasound.

The **CHOTs** technology **addresses** all the **limitations noted above for current ultrasonic systems** . The CHOT device is a structure on the surface of the test component that is optically excited using lasers to either generate or detect ultrasound. There are two types of CHOT: one for ultrasound generation (g-

CHOT) and one for ultrasound detection (d-CHOT), and each part can work independently of the other. However, each offers the user full control of the excited/detected wave mode (type of ultrasonic wave), its directivity and the ultrasonic frequency content. This is achieved through appropriate design of the CHOT structure.

Both types of CHOT are operated remotely by directing a laser onto the surface of a CHOT. For the generation of ultrasound a pulsed laser is required while a CW laser is used to detect an ultrasound signal. Aligning these lasers onto their respective CHOT device is a simple task (point and shoot) provided the CHOTs are illuminated by part of the laser beam the ultrasound signal will be generated or detected as appropriate. Thus, only simple, low cost optics are required for this process. A portable device to excite the CHOTs and process the ultrasonic signal is underway.

The CHOTs themselves **can be produced** using a **range of methods** , for example contact printing, laser etching and photolithography, or attached as printed stickers and left in place. These methods of production mean that the CHOTs themselves are **cheap** to produce and can be regarded as **disposable** . This opens up a whole new range of potential markets for ultrasound testing that have yet to be explore

Advantages

·Platform technology for **non-contact** ultrasonic NDT
·Allows remote operation between user and CHOT (up to hundreds of metres) permitting a wide range of applications:
·in-service testing (continuous monitoring), e.g. turbine blades;
·use in hostile environments, e.g. furnaces or radioactive zones;
·quality control in production lines
·CHOTs are:
· **small** , so have minimum impact when installed on a test component;
· **low cost** ;
·can be permanently installed;
·or be disposable (opens up new markets)
·Can cope with test components of unusual shape
·Range of ultrasonic waves can be generated
·Can use IIIA/3R lasers (no eye protection required)
·Laser beam can be fibre coupled if required

Institution

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